PUBLIC WORKS DEPARTMENT
GOVERNMENT OF INDIA

IRRIGATION IN INDIA

REVIEW
for
1917-1918



SIMLA:
PRINTED AT THE GOVERNMENT MONOTYPE PRESS.
1919.

CONTENTS.



BIRDS EYE VIEW, UPPER SWAT CANAL.

IRRIGATION IN INDIA.

Review for the year 1917-18.

CHAPTER I.

INTRODUCTORY.

Preliminary.

Irrigation works, the object of which is the artificial applica-

countries, from time immemorial. This is a natural result of the conditions of climate. India contains large tracts, such as the deserts of Sind and the south-western Punjab, which are practically rainless, and in which cultivation without irrigation is impossible. There are others, such as the Deccan plateau and the Bundelkhand districts of the United Provinces, where cultivation is extremely precarious, owing to the great irregularity of the rainfall and the long intervals during which crops may be exposed to the fierce heat of the sun, and to dry and scorching winds. In such regions there may be an almost complete failure of crops in a year of short or badly distributed rainfall, and a succession of two or more unfavourable seasons may result in famine. There are also districts which ordinarily receive so copious a rainfall that rice is almost the only crop grown, but even for this, water is required at certain critical periods, as when a break occurs in the rains, and a full harvest can in such cases only be secured by irrigation. In general it may be said that the security of the harvest depends on the existence of some form of irrigation in almost all parts of India, except in tracts such as Eastern Bengal, Assam and Lower Burma, where the average rainfall does not fall short of 70 inches per annum.

Different types of irrigation works.

Irrigation works may be conveniently divided into three great types, namely, lift, storage, and river works, which are represented by wells, tanks or reservoirs, and canals. In lift-irrigation, the water is raised from a lower level to that which will command the area to be irrigated, the raising being effected either by manual labour or by animal or mechanical power. The source of supply is usually the sub-soil water into which wells have been sunk, but lift-

appliances are often erected on the banks of rivers or pools fi which water is raised to the lands to be irrigated. Storage wo are reservoirs, formed by the construction of dams across drain lines, for the purpose of storing the supply which passes down af every heavy fall of rain, for subsequent use during long breaks [illegible] cases they include a weir, which is constructed across the bed the river immediately below the off-take of the canal, for the pu [illegible]

Lifting appliances, for example, are sometimes required to rai water from canals to ground on a higher level. Large storag works are incomplete without a network of distributing channel and canals taking off from rivers in which the supply is uncerta and intermittent require storage works which may be constructe either at some distance up-stream from the head works, in th valley of the main river or of a tributary, or as "tail tanks" a suitable points on the line of the canal itself.

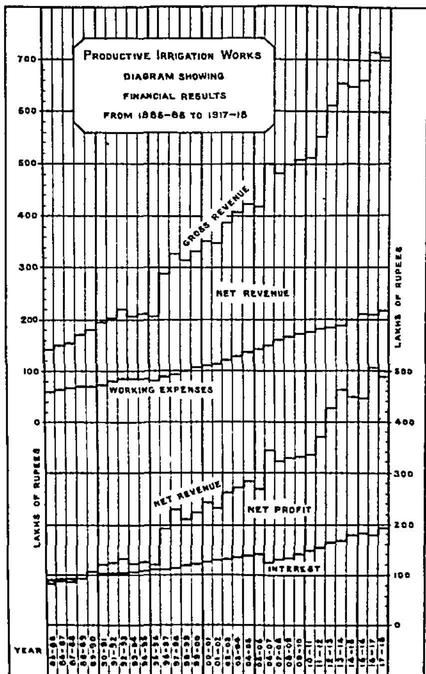
Well Irrigation. This review does not purport to deal in any way with the sub ject of well irrigation, which does not fall within the scope of th operations of the Public Works Department. Well irrigation i India is usually left entirely to private enterprise, although of lat years the Agricultural Department of Government has done great deal towards the improvement of such irrigation, and th introduction of mechanical methods of raising water to the surfac of the land.

Storage works. Tanks or storage works are of all sizes, ranging from great lake formed by the construction of high dams across the beds of larg but irregularly flowing rivers, such as certain of the monumenta works now under construction in the Western Ghats where dam up to 270 feet in height are being built, and lakes formed thereby capable of holding up to 24,000 million cubic feet of water, to th small village tanks to be found throughout Southern India, man of which irrigate less than 10 acres. The importance of storag works in India is steadily increasing, since the water in the grea majority of those rivers capable of providing perennial irrigatio is already utilised for the purpose, and the main prospects o expansion lie in the construction of works of this kind. Thus, i

the Punjab, the cold weather supply of the Sutlej being already hypothecated to existing canals, it is now proposed to provide further volumes during this season by impounding water during the rains. This will be effected by means of a colossal reservoir, which will store large quantities of the monsoon supply which at present runs to waste. The dam which will form the proposed reservoir will be the highest in the world Similar works are also under consideration in other provinces, especially in Madras.

River works.

Canal systems are of one of two kinds, either perennial or inundation. Strictly speaking, a perennial canal is one which has an assured supply of water all the year round, but this generally involves the construction of a weir or, as it is called in Southern India, an anicut across the bed of the river to hold up the low supply and divert the whole or as much as may be needed into the canal As a general rule, a canal which takes off from above a properly constructed weir is assured of a fairly continuous supply during the season when water is required, and it is possible by this means to utilise the whole of the water that comes down, however low the state of the river. The term "perennial" is therefore generally applied both to canals which can draw off a constant supply without the assistance of a weir, and those which are provided with weirs which render the supply to the canal dependent only on the quantity of water in the river and not on its surface level. Inundation canals are simply channels taking off from the banks of a river at a level which is generally considerably higher than the ordinary low water level of the stream. Water flows into these cuts during the flood season, and they remain in flow until the river falls below the level of their beds, which is generally two or three feet higher at the end than at the beginning of the season owing to silt deposits which have to be cleared out during the period when the river is low. The most important inundation canals are to be found in the Punjab and Sind, *i.e.*, in the valley of the Indus and its tributaries. They are in flow generally from the beginning of May until the end of September, although the supplies fluctuate greatly during these months with the surface levels in the river. Cultivation, which is practically impossible without irrigation in the rainless tracts they serve, has adapted itself to these conditions. It will, however, readily be understood that irrigation from inundation channels is subject to strict limitations and can never be as secure as that dependent upon perennial canals, and consequently several projects are at present under consideration, chief among which may be mentioned the Sutlej Valley Project in the Punjab and the Sukkur Barrage Project in Sind, which contemplate the substitution of perennial irrigation for the present insecure inundation supplies.


PRODUCTIVE IRRIGATION WORKS
DIAGRAM SHOWING
FINANCIAL RESULTS
FROM 1885-86 TO 1917-18
GROSS REVENUE
NET REVENUE
WORKING EXPENSES
NET REVENUE
NET PROFIT
INTEREST
LAKHS OF RUPEES
LAKHS OF RUPEES
700
600
500
400
300
200
100
0
500
400
300
200
100
0
YEAR
85-86
86-87
87-88
88-89
89-90
90-91
91-92
92-93
93-94
94-95
95-96
96-97
97-98
98-99
99-00
00-01
01-02
02-03
03-04
04-05
05-06
06-07
07-08
08-09
09-10
10-11
11-12
12-13
13-14
14-15
15-16
16-17
17-18

Protective works. Protective irrigation works are those which, although not directly remunerative to the extent which would justify their inclusion in the class of productive works, are constructed with a view to the protection of precarious tracts and to guard against the necessity for periodical expenditure on the relief of the population in times of famine. The cost of these works is a charge against the current revenues of India, and is generally met from the annual grant for Famine Relief and Insurance. The construction of each such work is separately justified by a comparison of the value of each acre protected (based upon such factors as the probable cost of famine relief, the population, the area already protected and the minimum area which should be protected in order to tide over a period of severe drought) with the cost of such protection. Among the larger works of this class already in operation may be mentioned the Godavari Canal in Bombay, constructed at a cost of a crore of rupees, the Betwa Canal in the United Provinces costing Rs. 83 lakhs and the Tribeni Canal in Bihar and Orissa costing Rs 77 lakhs. Amongst projects of this class under construction the most important are the Nira Right Bank Canal in Bombay estimated to cost Rs. 258 lakhs, the Pravara Canals, also in Bombay, estimated to cost Rs. 117 lakhs and the Tandula Canal in the Central Provinces estimated to cost a crore of rupees.

Minor works Minor works comprise those irrigation and navigation works not classed as productive or protective, and agricultural works which are undertaken for the general improvement of the country. The outlay upon them is met from current revenues. Some of them are old works constructed by the former rulers of the country and extended or restored by the British Government, some have been constructed by the British Government, and others are village [illegible] the con- t[illegible] disputes b[illegible] ntain the works in an efficient state of repair. Capital and revenue accounts are kept of these works where they cost more than Rs. 50,000 and where it is anticipated that the expenditure derived from them will suffice to cover the working expenses.

Agricultural works. The so-called agricultural works which are included in the category of minor works consist mainly of protective embankments [illegible] the purpose of irrigating these lands.

CHAPTER II.

RESULTS OF IRRIGATION OPERATIONS DURING THE YEAR 1917-18.

Climatic conditions and demand for irrigation.

As already stated in Chapter I, the purpose of artificial irrigation is to supplement the rainfall on which the welfare and prosperity of India so largely depends, and consequently the demand for canal irrigation fluctuates considerably with the nature of the monsoon and the intensity of the winter rains. When the rainfall is copious and well distributed there is little demand for artificial irrigation, but, in the event of a failure either of the monsoon or of the winter rains, the canals are taxed to their utmost capacity and the officers responsible are then faced with the difficult task of allotting the available supplies in the most equitable manner, so as to provide for the irrigation of as large an area as possible. These difficulties had not, however, to be faced during the year 1917-18, for the monsoon of 1917 was most propitious and the rainfall abundant, especially during the month of September which is the most critical period of the agricultural year. During the monsoon period from June to September 1917, the total rainfall in the plains of India was, as a whole, some 17 per cent. in excess of normal, this being the highest excess ever recorded.

In the Punjab and north-west of the United Provinces, the rains broke in the first week of June. During July, the monsoon, although of average strength, was unsteady, and frequent partial breaks occurred, but an appreciable improvement took place in August, in which month precipitation over the whole country was in excess of the normal. There was a well-marked break during the first fortnight of this month in the interior of the Peninsula, but in Northern India the rainfall was almost continuous. The monsoon current during September was exceptionally strong and gave abundant rain over nearly the whole of India, no long breaks occurred in any part of the country, and the rainfall during the month, averaged over the plains of India, exceeded the normal by more than 50 per cent., this being the largest excess recorded in September since 1875.

The monsoon rainfall of 1917 was thus remarkable for its unusual abundance, especially in north-west and central India, and for the absence of any extensive break, and consequently the areas irrigated by the Government canals were considerably restricted, the heavy and late rainfall permitting the winter crops to be sown largely without the aid of canal water.

During the year under review the total area irrigated by all classes of works in India, excluding the areas irrigated in the Native States, amounted to nearly 26 million acres or about 40,625 square miles. Towards this area the Productive Works contributed 16,922,000 acres, the Protective Works 497,000 acres, and the Minor Works 8,477,000 acres.

Total area irrigated.

The area irrigated by Productive Works was greatest in the Punjab, where over 7½ million acres were recorded. The Madras Presidency came next with an area of 3½ million acres, while in the United Provinces and Sind, the areas irrigated by the Productive Canals amounted to 2,871,000 acres and 1,364,000 acres, respectively. Bihar and Orissa contributed 798,000 acres, the North-West Frontier Province 362,000 acres, and Burma 264,000 acres.

Areas irrigated and returns realized by Productive Works.

The total capital outlay, direct and indirect, to the end of the year on Productive Irrigation Works, including those under construction, amounted to nearly 57¾ crores The gross revenue for the year amounted to 701½ lakhs and the working expenses to nearly 216½ lakhs The net revenue was therefore a little over 485 lakhs which represents a return of 8·40 per cent. on the total capital outlay. This figure indicates the remunerative character of the Productive Irrigation Works of India, especially when it is considered that this percentage represents only receipts from water rates and a share of enhanced land revenue, and that no credit is given for the large additional revenues, due directly to the opening up of new tracts by irrigation, which are obtained by the railways and under such heads as stamps, postage, salt, etc. In the several Presidencies and Provinces the return on capital outlay was highest in the Punjab, where the canals yielded 11·95 per cent. In Madras, including schemes which have proved unremunerative, the percentage of return was 9 95, while in the United Provinces and Sind returns of 8 62 and 6 03 per cent. respectively were realized.

The total area irrigated by the thirty-six Protective Works in operation during the year under review amounted to 497,000 acres. Towards this the United Provinces contributed nearly 200,000 acres and Madras nearly 107,000 acres. In the Deccan and Gujarat nearly 70,000 acres were irrigated In the two other provinces where Protective Works are in operation, 65,000 acres were irrigated in Bihar and Orissa and 51,000 acres in the Central Provinces.

Protective Works.

The total capital outlay on works of this class amounted to over 1 012½ lakhs at the end of the year under review. The net revenue for the year was only a little over one lakh, which is equivalent to 0 10 per cent. on the total capital outlay. This low return

is partly due to the fact that the capital account is at present swelled by expenditure on works under construction which have not yet commenced to earn revenue. Many useful and important works of this nature are under construction in Bombay, the United Provinces and the Central Provinces, while in the last named province seven tank schemes, aggregating over 40 lakhs, are in progress. Details of these works will be found in the chapters in Part II of this Review relating to the progress of irrigation in the Province or Administration concerned.

Minor Works.

Minor works are of two kinds, as described in Chapter I of this Review. These works are, for purposes of accounting, subdivided into three classes as described below:—

Class I.—Works for which Capital and Revenue Accounts are kept. These are works the estimated capital cost of which exceeds Rs. 50,000 and the revenue from which is expected to cover the total working expenses.

Class II.—Works for which only Revenue Accounts are kept. These are generally works costing less than Rs. 50,000.

Class III.—Works for which neither Capital nor Revenue Accounts are kept. The works of this class consist mainly of small tanks and field embankments or small drainage schemes to prevent deterioration of land or to effect improvement of land with a view to rendering it fit for cultivation.

121 Minor works of the first class described above were in operation at the close of the year 1917-18, 113 being irrigation works and 8 navigation works, the area irrigated by the former amounting to 2,262,000 acres. The total capital outlay on irrigation works of this class at the close of the year was nearly 448 lakhs, and the net revenue amounted to Rs. 35,29,000, representing a return of 7·88 per cent. on capital. On the eight purely navigation works referred to above, the total capital outlay at the end of 1917-18 amounted to nearly 231 lakhs, a return of 0·42 per cent. being realized. The net revenue realized during 1917-18 from Class I Irrigation and Navigation Works as a whole yielded a return of 5·34 per cent. on a total capital outlay of about 678½ lakhs. An area of 2,796,000 acres was irrigated by Minor works of Class II while the Class III works effected irrigation to the extent of 3,419,000 acres. The total area irrigated by Minor works of all classes thus amounted to 8,477,000, or just one-third of the total area irrigated during the year by Government canals.

A comparison of the acreage of crops matured during 1917-18 by means of Government irrigation systems, with the total area under cultivation in the several provinces is given below :—

Comparison of total cropped area with the area irrigated.

Province.	Net area cropped.	Area irrigated by Government irrigation Works.	Percentage of irrigated area to total cropped area.	Capital cost of Government irrigation works to end of 1917-18 in lakhs of rupees.	Estimated value of crops raised on areas receiving State irrigation in lakhs of rupees.
	Acres.	Acres.		Rs.	Rs.
Burma	14,668,000	1,448,00	9·9	278	442
Bengal	24,452,000	113,00	0 5	249	57
Bihar and Orissa ..	8,131,000	866,000	10·6	629	395
United Provinces of Agra and Oudh.	35,808,000	3,209,000	9 0	1,259	1,763
Ajmer-Merwara ..	365,000	19,000	5·2	35	7
Punjab	28,253,000	8,600,000	30·4	2,239	3,337
North-West Frontier Province.	2,958,000	362,000	12 2	273	180
Sind	4,000,000	3,507,000	87·7	328	833
Bombay Deccan ..	25,705,000	305,000	1·2	506	243
Central Provinces (excluding Berar).	19,290,000	145,000	0·8	327	60
Madras	38,821,000	7,359,000	19·0	1,114	2,466
Baluchistan	257,000	17,000	6·6	42	5
Total ..	202,708,000	25,950,000	12·8	7,279	9,797

It will be seen that nearly 13 per cent. of the cropped area is irrigated by Government irrigation works, and that the estimated value of the corps so irrigated in a single year exceeds by 35 per cent. the total capital expended on these works.

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Comparison with the results of previous triennium.

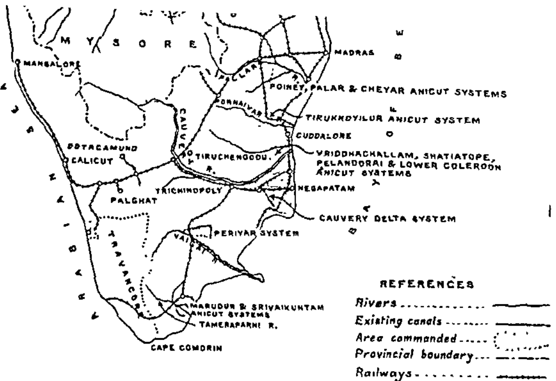
The following table compares the area irrigated by Government works during the year under review with the average area so irrigated during the previous triennium.

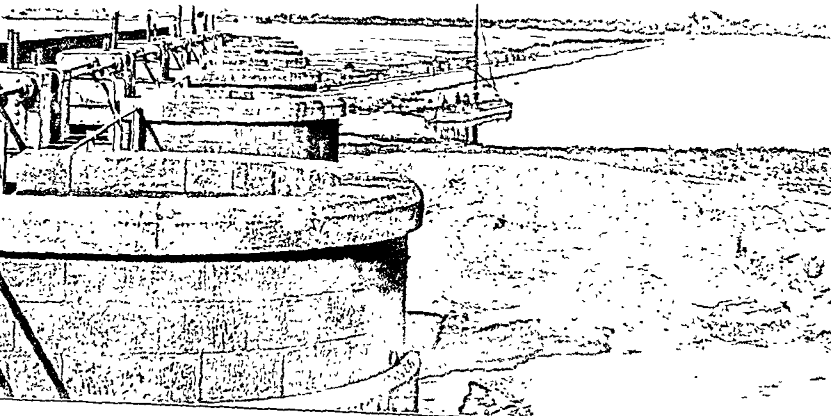
Province.	Productive		Protective		Minor.		Total	
	1914-15 to 1916-17.	1917-18.	1914-15 to 1916-17	1917-18	1914-15 to 1916-17	1917-18	1914-15 to 1916-17	1917-18.
	Acres	Acres	Acres	Acres	Acres	Acres.	Acres.	Acres
Madras	3,454,518	3,526,831	107,111	106,866	3,717,521	3,725,132	7,279,183	7,358,829
Bombay Deccan	31,870	43,691	76,751	69,970	173,668	190,962	282,289	304,623
Sind	1,421,125	1,363,789			2,230,131	2,143,329	3,651,256	3,507,118
Bengal .. .	82,505	86,726		..	25,295	26,429	107,800	113,225
United Provinces .	2,815,245	2,871,087	172,259	199,831	153,612	138,507	3,141,116	3,209,425
Punjab . .	7,522,509	7,531,316	.	.	987,639	1,069,842	8,510,148	8,600,158
Bihar and Orissa ..	845,311	798,068	59,907	65,971	1,447	1,727	906,665	865,769
Burma	268,962	263,656		.	1,029,923	1,184,248	1,298,885	1,447,904
Central Provinces .	29,541	74,794	32,076	54,824	17,091	16,333	78,708	145,451
North-West Frontier Province.	295,679	362,000		.	2,500	.	298,179	362,000
Rajputana	..	.	.	..	25,255	19,129	25,255	19,129
Baluchistan ..	..	..	..	.	6,540	16,816	6,540	16,816
Total ..	16,767,395	16,922,018	448,104	496,962	8,370,625	8,531,494	25,586,114	25,950,474

Comparison with the results of previous triennium.

The following table compares the area irrigated by Government works during the year under review with the average area so irrigated during the previous triennium.

Province.	Productive.		Protective.		Minor.		Total.	
	1914-15 to 1916-17.	1917-18	1914-15 to 1916-17	1917-18	1914-15 to 1916-17	1917-18	1914-15 to 1916-17.	1917-18.
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres.
Madras	3,454,519	3,526,831	107,111	106,866	3,717,524	3,725,132	7,279,183	7,358,829
Bombay Deccan	31,870	43,691	76,751	69,970	173,668	190,962	282,289	304,623
Sind	1,421,125	1,363,789		.	2,230,131	2,143,329	3,651,256	3,507,118
Bengal .. .	82,595	86,786		.	25,235	26,439	107,830	113,225
United Provinces ..	2,815,245	2,871,087	172,259	190,831	153,612	138,5?7	3,141,116	3,200,425
Punjab ..	7,522,509	7,531,316	.	..	987,639	1,069,842	8,510,148	8,600,159
Bihar and Orissa ..	845,311	798,068	60,007	65,971	1,447	1,727	906,665	865,766
Burma .. .	268,962	263,656		.	1,029,923	1,184,248	1,298,885	1,447,904
Central Provinces .	29,541	74,794	32,076	54,324	17,091	16,333	78,708	145,451
North-West Frontier Province	295,679	362,000	..	.	2,500	.	298,179	362,000
Rajputana . ..	.	.		..	25,255	19,129	25,255	19,129
Baluchistan ..	..	..	..	..	6,540	16,816	6,540	16,816
Total ..	16,767,335	16,922,018	448,104	496,962	8,370,625	8,531,494	25,586,114	25,950,474


MYSORE
MADRAS
MANGALORE
POINEY, PALAR & CHEYAR ANICUT SYSTEMS
PALAR R.
PONNAIYAR
TIRUKKOYILUR ANICUT SYSTEM
CUDDALORE
OOTACAMUND
CALICUT
CAUVERY R.
TIRUCHENGODU.
VRIDDHACHALLAM, SHATIATOPE, PELANDORAI & LOWER COLEROON ANICUT SYSTEMS
TRICHINOPOLY
NEGAPATAM
PALGHAT
CAUVERY DELTA SYSTEM
PERIYAR SYSTEM
VAIGAI R.
TRAVANCORE
MARUDUR & SRIVAIKUNTAM ANICUT SYSTEMS
TAMERAPARNI R.
CAPE COMORIN
REFERENCES
Rivers
Existing canals
Area commanded
Provincial boundary
Railways



DOWLAISHWERAM ANICUT, EASTERN GODAVARI SYSTEM.

Part II.—Progress of Irrigation in the various Provinces and Administrations.

CHAPTER III.

MADRAS.

Irrigation prior to the advent of British rule.

PRIOR to the advent of British rule, irrigation from tanks and inundation channels had for many centuries been extensively practised in Madras. Only a few permanent works for the diversion of river supplies existed, however, and the only attempt to control a large river for the purpose of irrigation was the weir on the Cauvery, known as the Grand Anicut, a work of considerable antiquity dating from the time of the Chola kings.

The Cauvery System, 1800-1836.

The earliest improvements undertaken by the British Government after the cession of Tanjore in 1800 were directed towards the extension of the area irrigated by the Cauvery. In 1830, scouring sluices were constructed in the Grand Anicut and six years later the Coleroon, a branch of the Cauvery, was spanned by two great weirs, the Upper Anicut, which regulates the supply drawn off by the Coleroon from the Cauvery and the Lower Anicut, which serves the area irrigated from the Coleroon. These works remained substantially as constructed until the beginning of the present century, when they were entirely remodelled; the area of 667,000 acres dependent on the ancient system has now expanded to over a million acres.

Progress from 1836-1856. The Godavari System.

There was a lull in the construction of irrigation works during the ten years following the building of the works on the Cauvery in 1836, but several schemes were evolved during this period and between 1847 and 1857 works were carried out, which have resulted in an extension of irrigation to about 1,100,000 acres of land. Chief amongst them is the Godavari anicut system. In 1844 the condition of the Godavari district attracted serious attention. For ten or twelve years the district had suffered from a series of seasonal calamities and the difficulties of the raiyat population had been accentuated by the harsh treatment accorded to it by the zamindars. The population, which was reported in 1821-22 to be nearly 750,000, fell by 1842-43 to a little over 550,000. It is difficult to compare these figures with the population of the present day, owing to the various changes which have occurred in the limits of the district, but it is fairly certain that the highest figure here quoted is less than half of the population at the census of 1871.

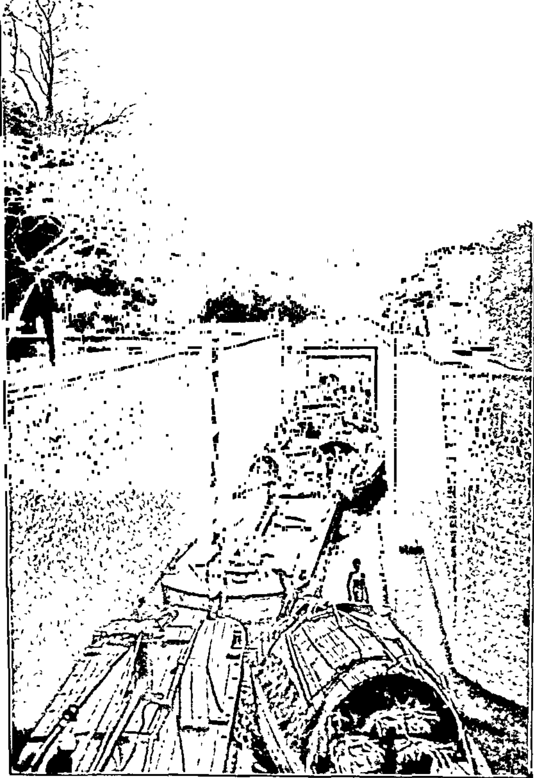
It is however possible to estimate that the density of the population in 1842-43 was approximately 75 to the square mile; it is now 266 for the whole district, but in the delta taluks it rises to close on 600 to the square mile.

There had been a certain amount of artificial irrigation in the delta but, owing to the nature of the channels, the supplies were unreliable and it was estimated, when the inquiries were set on foot with regard to the construction of the Godavari anicut, that the cultivated irrigable area was a little over 156,000 acres. As a result of these inquiries, the construction of the anicut was sanctioned at the end of 1846 and the work was completed about five years later. By 1866-67 the irrigated area had increased to 408,000 acres, and, owing to improvements subsequently carried out, irrigation under this system is still being extended and 1,026,000 acres were supplied in 1917-18. In addition to the benefit of irrigation, the lands have been protected from floods by embankments, and relief has been given by cutting drainage channels. Failure of crops has been practically unknown since the construction of the project, and the main canals, which are navigable for about 500 miles, furnish also an excellent means of communication by boat.

The annual land revenue of the district was formerly less than 15 lakhs and was collected with difficulty. The annual revenue from the delta taluks alone in now Rs. 48 lakhs and is collected with ease. The estimated value of the cargoes transported annually by the canals is nearly 850 lakhs of rupees, and about 500,000 passengers are carried yearly. Land, which was previously practically unsaleable, now fetches about Rs. 600 an acre on an average. The delta, which was formerly one of the areas most liable to famine, is now an expanse of paddy fields broken by gardens of fruit trees.

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The area now irrigated by the Kistna anicut system suffered severely from famine in 1832 like the adjoining Godavari district. The famine was followed by a severe outbreak of fever, and in 1833-34 it was found that the population had fallen from 512,000 to 256,000. The anicut and head works were commenced in 1852 and completed in 1855 but the system of main canals, distributaries, embankments and drainage was not completed until some years later. Before this the population had begun to recover but the density per square mile was less than 140; it is now well over 300. The area of old irrigation, which was about 71,000 acres, has increased more than tenfold, and 729,000 acres were irrigated from the system in 1917-18.



DOWLAISHWERAM GODAVARI DELTA SYSTEM.

350 miles of the main canals are navigable and form an extra means of communication for half the year, cargoes valued at over a crore of rupees being carried annually by boats. Land which was practically valueless before the system was constructed now fetches 600 rupees an acre or more. The delta is not so rich as the Godavari delta because the Kistna cannot give water for more than a single crop in the year, and the landscape is not broken in the same way as that of the Godavari delta by innumerable gardens of fruit trees. Famine is, however, now unknown; the disastrous widespread floods have been generally controlled, and the country shows every sign of wealth and prosperity.

General review of the period.

Other works built during this period were the two anicuts on the Gadilam, the Shatiatope anicut on the Vellar, and the anicuts on the Penner, Poiney, Cheyyar and Palar rivers. This period was throughout one of unprecedented activity and the results have proved satisfactory in the extreme, the two largest systems, the Godavari and Kistna, having in the past year produced net revenues amounting to 22 per cent. and 18 per cent. respectively on their capital outlay. The main credit for these works is due to the late Sir Arthur Cotton, the famous Madras engineer, who also built the two great anicuts on the Cauvery referred to in the previous paragraph.

Kurnool-Cuddapah Canal, 1861-1882.

In 1861 a company known as the Madras Irrigation Company, [illegible] began the construction of an [illegible] canal therefrom, 190 miles in [illegible] rnool-Cuddapah Canal, formed, with the Orissa Canal then under construction in Bengal, part of a colossal series of works that was to connect eventually such distant ports as Calcutta, Cuttack and Madras on the east, with Bhatkal and Mangalore on the west coast; some 150,000 square miles of country were to be opened up by navigation and over a million acres irrigated. By 1866 the Company had exhausted its funds, but work was continued on a loan of £600,000 from the Secretary of State. Irrigation commenced in 1864 with an area of 200 acres which slowly [illegible] reason for the failure of the work lies in the fact that, in ordinary years, the rainfall is sufficient for unirrigated crops while the soil is generally unsuitable for irrigated crops. Extensions in the Cuddapah district, where these objections to irrigation do not hold, are now under construction, and the area irrigated is steadily increasing. The areas supplied in years of scarcity have, however, demonstrated the great value of the canal as a famine protective work, although it is not at present classed as such.

Works constructed from loan funds, 1866-1876.

In 1866 an important change in policy took place, the Government of India intimating their intention of carrying out large irrigation works of a remunerative nature from loan funds Two anicuts, on the Gadilam and Ponniar respectively, had just been completed when the change was announced, and in the following decade four more such works were constructed, one each on the Tambraparni and Vellar and two on the Manimuktanadhi.

Early storage works in Madras, 1876-1896.

In the case of all the works constructed up to this time, the natural supply in the rivers was diverted either directly on to the fields or into existing tanks, which were in some cases enlarged. With the completion of the Vellar anicut in 1876 this class of work was exhausted, and it became evident that further extensions of irrigation would necessitate the construction of new storage systems. Four such projects were carried out in the eighties on the recommendation of the Famine Commission which toured India in 1878-80 under Sir John Strachey. These four projects comprised the Sangam system, the Barur tank system, the Rushikulya system and the Periyar system The Rushikulya system was the first famine protective work to be constructed in the Madras presidency and it has extended new irrigation to some 48,000 acres besides protecting 58,000 acres of old irrigation. The Periyar lake is perhaps the boldest and most interesting reservoir scheme in India and deserves special mention The Periyar river has its source in the Western Ghats whence it flows westwards through Travancore, the Madras engineers constructed an immense masonry dam, 175 feet in height (no light task in an almost inaccessible gorge 3,000 feet above the sea), which created a reservoir of 9,600 million cubic feet capacity, the water from which is carried through the range by means of a [illegible]

were irrigated from it, as compared with 66,000 acres supplied from other sources in the same area before the reservoir was built

Improvements to existing works, 1896-1904.

With the completion of the Periyar project the construction of [illegible]

Vellar being converted during this period from solid weirs into regulators with large-span lift shutters operated from a bridge overhead.

Developments since 1905.

Since 1905 five projects of considerable magnitude have been taken in hand. The Nagavalli River system, a productive work, came into operation in 1910, and the Toludur project, also a work of the same category, which is designed to irrigate 25,000 acres from a

reservoir of 2,400 million cubic feet capacity, is approaching completion. Two famine protective projects, the Mopad reservoir and the Bhavanasi tank, were commenced in 1905 and 1906 respectively, but on its becoming apparent that the sanctioned estimates would be largely exceeded, the works were closed down in 1907. Revised estimates were sanctioned in 1911 and the works re-started; the former project will, it is anticipated, irrigate a small area in 1919 and the latter has come into operation in 1918.

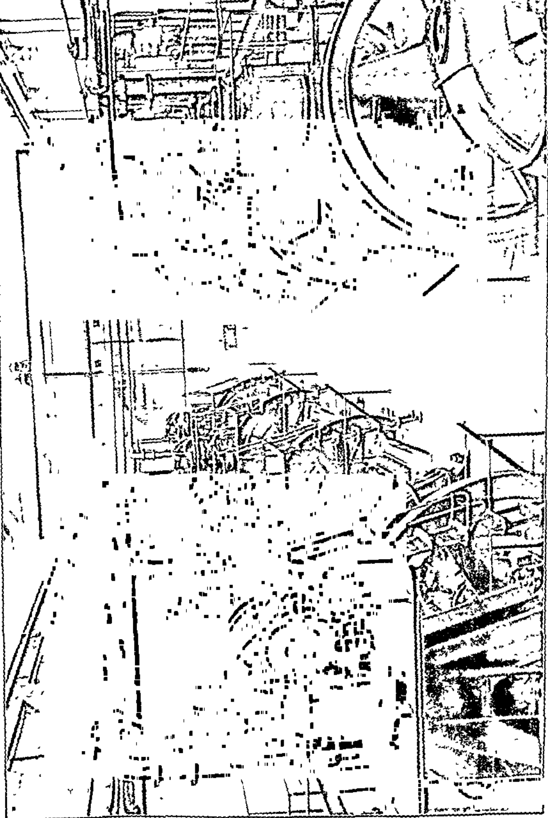
Divi Pumping System.

The fifth project is that known as the Divi pumping system. The scheme provides for the irrigation of 50,000 acres in Divi Island, a tract of land about 150 square miles in extent situated at the mouth of the Kistna river, by means of centrifugal pumps driven by crude oil Diesel engines. Construction work commenced in 1906 and pumping for irrigation started in 1907. The pumping plant, consisting of 8 double-cylinder 160 B. H. P. Diesel engines, each driving a 39-inch centrifugal pump, has been remarkably free from breakdowns and its efficiency has been well maintained. The cost of pumping, including the cost of establishment, was Rs. 1-2-9 [illegible] ration to Divi Island and the resident ryots had as much land as their dependents could cultivate. Owing to the war and the consequent difficulty in getting spare parts for the pumping plant, further extension of irrigation in 1918 has been discouraged. It is under consideration to supplement the power now developed at Divi by hydro-electric power to be generated at certain canal falls in the Kistna Eastern delta. A similar pumping scheme for the irrigation of 10,000 acres in the Guntur district, by pumping from the Kistna river at Pratur, 4 miles below the Bezwada anicut and about 36 miles above the head of Divi Island, is under investigation, and it is proposed in this case to obtain the necessary power from a canal fall in the Kistna Western delta.

Increase in irrigated area during past half century.

During the past half century the area irrigated by productive and protective works has more than doubled. The steady increase which has taken place is shown by the following figures:—

Year.	Area irrigated in acres.
1867-68	1,518,000
1877-78	1,789,000
1887-88	2,114,000
1897-98	2,700,000
1907-08	3,338,000
1917-18	3,634,000



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Scope for further extensions of irrigation in Madras—Major projects.

As a result of the recommendations of the Irrigation Commission of 1903, three large projects on the Tungabhadra, Kistna and Cauvery rivers were investigated in detail. The Tungabhadra project had, however, to be abandoned on account of its prohibitive cost. The Kistna project, which involves the construction of a dam 154 feet high, storing 163,586 million cubic feet of water, has been estimated in detail, the anticipated cost amounting to 834 lakhs of rupees; but its further consideration has been postponed, as the Cauvery scheme is the more promising of the two, and it is realised that it would be impossible to undertake both simultaneously. The latter project provides for a dam at Metur on the Cauvery about 35 miles above Erode, to store 80,000 million cubic feet of water, for a canal 78 miles long, with a connected distributary system, taking off from the right bank of the Cauvery at the Grand Anicut; and for the improvement and extension of the existing Vadavar canal. The project is estimated to cost 4 crores of rupees, and to give a return of over 5 per cent on the capital cost; it provides for the complete control of the present fluctuating supplies to the Delta and for an area of 371,000 acres of new irrigation.

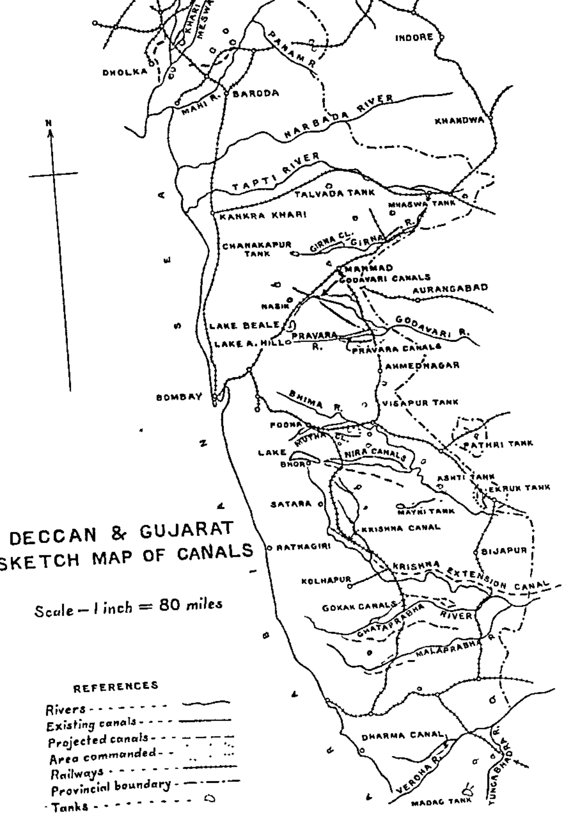
Minor projects.

In addition to the investigation of these important and formidable works, practically every possible irrigation scheme of any magnitude was examined by a special staff during the quinquennium 1901-06. In all 86 projects were investigated, of which 17, estimated to cost 120 lakhs, have either been completed or are under execution. Of the remainder, 5 have been sanctioned as famine relief projects, 26 have been abandoned as impracticable, 14 are either being further investigated or are under the consideration of the local Government, 16 are in abeyance either pending the verification of the water supplies available or awaiting the orders to be passed on other projects, while the remaining 8 will be carried out if the water-rate necessary to render them productive can be guaranteed.

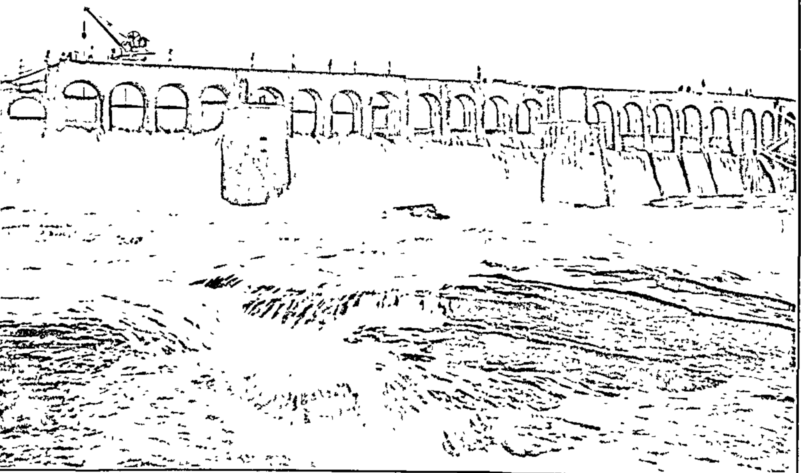
Progress anticipated.

The table below shows the extensions of irrigated area which are anticipated when the principal works recently completed, under construction or under consideration are in full working order:—

Stage of work.	Name of work.	Area in acres.
Recently completed . .	Nagavalli system . . .	23,814
	Divi pumping system . .	50,000
	Venkatapuram tank system .	1,705
	Bhavanasi tank system . .	841
Under construction . .	Toludur Project . . .	26,851
	Mopad project . . .	12,500
Submitted for sanction .	Cauvery Reservoir project	371,000
	Total . .	486,711



DECCAN & GUJARAT
SKETCH MAP OF CANALS
Scale – 1 inch = 80 miles
REFERENCES
Rivers
Existing canals
Projected canals
Area commanded
Railways
Provincial boundary
Tanks
N
DHOLKA
KHARI
MESWA
PANAM R.
INDORE
MAHI R.
BARODA
NARBADA RIVER
KHANDWA
TAPTI RIVER
TALVADA TANK
MHASWA TANK
KANKRA KHARI
GIRNA CL.
GIRNA R.
CHANAKAPUR TANK
MANMAD
GODAVARI CANALS
AURANGABAD
NASIK
GODAVARI R.
LAKE BEALE
PRAVARA R.
LAKE A. HILL
PRAVARA CANALS
AHMEDNAGAR
BOMBAY
BHIMA R.
VISAPUR TANK
POONA
MUTHA CL.
PATHRI TANK
LAKE
BHOR
NIRA CANALS
ASHTI TANK
EKRUK TANK
SATARA
MAYNI TANK
KRISHNA CANAL
RATNAGIRI
BIJAPUR
KRISHNA EXTENSION CANAL
KOLHAPUR
GOKAK CANALS
GHATAPRABHA RIVER
MALAPRABHA R.
DHARMA CANAL
VERDHA R.
TUNGABHADRA R.
MADAG TANK



WASTE WEIR, LAKE FIFE, MUTHA CANAL.

CHAPTER IV.

BOMBAY.

(1) *Deccan and Gujarat*

General conditions in the Deccan and Gujarat.

In the Deccan and Gujarat the cultivation depends chiefly upon rainfall, and the tanks and canals are mainly useful for the purpose of growing the more valuable crops or to counteract, when required, the evil effects of years of drought or of prolonged breaks in the monsoon. There are not many streams in the Deccan from which it is possible to obtain much water, except during the monsoon, and hence the necessity for the construction of costly storage reservoirs. Moreover, the Deccan plains are most irregular and a canal cut through them has to overcome numerous difficulties in regard to slope, soil and alignment.

Panjhra River works, 1851.

The oldest of the Government irrigation works in the Deccan are the Panjhra River works in Khandesh. They date from 1851-52, and were constructed at a cost of about 5 lakhs of rupees for the irrigation of about 13,000 acres.

Progress from 1852-1870.

After 1852 there was a considerable interval during which no further projects were taken in hand, but between 1865 and 1870 a number of small works came into operation, of which the Kadwa river works in Nasik and the Krishna Canal in Satara were the most important. Six other smaller works also came into existence in various districts, extending from Khandesh in the north to Dharwar in the south.

Mutha Canal, [illegible]

Between 1870 and 1880 twelve more works were added, of which by far the most important was the Mutha Canal, built at a cost of 79 lakhs of rupees, with a large storage reservoir of 4,000 million cubic feet capacity at Lake Fife in the Poona district. The system now brings in a gross revenue of more than 4 lakhs of rupees per annum, but nearly two lakhs of this are obtained from the supply *of drinking water to Poona City and Cantonment.* Proposals for the separation of the accounts of the Poona Water Supply from those of the Mutha Canal are now under the consideration of the Government of India. 16,800 acres are irrigable from the canal, of which 5,000 acres are sown with sugarcane, the yield of the [illegible] being valued at 24 lakhs of rupees per annum. The Ekruk tank [illegible] the Hathmati and Khari Cut Canal system, each constructed [illegible] a cost of 13 lakhs, also belong to this decade. The Hathmati [illegible] was the first and is still the most important work in Gujarat.

Nira Left Bank Canal, 1880-1890.

A considerable impetus to the construction of irrigation works
great famine of 1876 and in the
1890, 12 new works came into
res of irrigable area to the previous total of 147,000 acres. The two largest works, the Nira Left Bank Canal and the Mhaswad Tank, were classified as protective works, the remainder falling in the category of minor works. The Nira Left Bank Canal, which receives its supply partly from the

of 65 lakhs of rupees and has proved a remarkably successful work, the net revenue having recently been as much as 6½ per cent. on the capital outlay. The Gokak Canal, a small canal taking off direct from the Ghataprabha river without a storage reservoir, was opened in 1884.

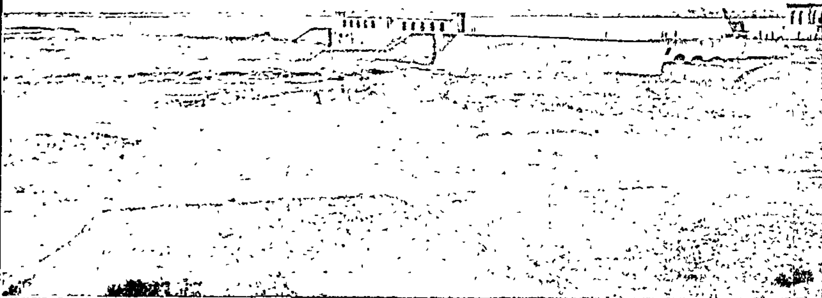
No progress made in 1890-1900.

During the decade from 1890 to 1900 no further advance was made. Most of the schemes constructed had not yielded the returns anticipated and the working expenses proved in many cases very much heavier than had been expected. The average area actually irrigated was less than one-third of the area considered as

century ended with a famine of exceptional severity and duration, which gave rise to a very earnest reconsideration of the measures necessary to improve the condition of the people and to combat scarcity and famine.

Progress since 1900. The Girna Left Bank and Godavari Canals.

The Irrigation Commission of 1903 gave much excellent advice as to these measures and this was promptly acted upon ; since that time very great progress has been made with large and useful irrigation works. The Girna Left Bank Canal, fed from the Chankapur tank, and constructed at a cost of 19 lakhs of rupees, has been completed except for an extension of the canal, which is now in progress. The irrigable area will eventually be 9,000 acres. The Godavari Left and Right Bank Canals, with storage at Lake Beale, have been practically completed at a cost of a crore of rupees. The dam is 92 feet high and 4,400 feet long and impounds nearly 9,000 million cubic feet of water. The canals are 117 miles in length and command an area of 220,000 acres in the Nasik and Ahmednagar Collectorates. This tract has always been liable to frequent periods of drought and suffered severely in the famines of 1876-77, 1896-97 and 1899-1900. The area irrigated and the net revenue earned by the Godavari canals during 1917-18 amounted to 22,000 acres and 70,000 rupees, respectively, but it is anticipated that ultimately an area of 42,000 acres will be irrigated yielding a net



NANDUR MADHMESHWAR WEIR, GODAVARI CANALS

revenue of 5 lakhs of rupees. In addition to the Godavari canals, five large tanks, the Dharma Canal and numerous small tanks came into operation during this period.

Works under construction. Pravara and Nira Right Bank Canals.

Two large protective works are under construction in the Deccan, *viz.*, (1) the Pravara River Works and (2) the Nira Right Bank Canal. The former consists of a right and left bank canal with a masonry dam on the Pravara river in the ghats at Bhandardara. The right bank canal has been completed and is in operation. The earthwork on the left bank canal has also been completed and the masonry works are in full swing. The dam has been carried up to a height of 165 feet and will be, when completed, 270 feet high [illegible] be carried out within the next five years at a cost of 127 lakhs of rupees. The canals, 85 miles long, will eventually be capable of irrigating 75,000 acres in the district of Ahmednagar which is very liable to famine, and a net revenue of 6½ lakhs of rupees is expected. [illegible] that ultimately 114,000 acres will be irrigated from it. The total quantity of masonry laid during the year was over 1½ million cubic feet and the progress on earthwork was equally satisfactory, considering the labour difficulties owing to the prevalence of plague and cholera. A revised estimate for the work is under preparation. The project, which is designed to serve large portions of the Poona, Satara and Sholapur districts and the Phaltan State, will confer widespread benefits on a tract of country which stands in urgent need of protection against the ravages of famine. The work is likely to be completed in 1928.

Works under consideration. Gokak Canal extension.

Of works in contemplation it is only necessary to mention the Gokak Canal extension, as no others can be taken up in the near future. This project has received the sanction of the Secretary of State, but as the cost of the Pravara and Nira projects proved to be much under-estimated the Government of India have asked that the Gokak Scheme should be again examined very carefully and resubmitted. The project consists of a reservoir at Daddi on the Ghataprabha, and a canal 75 miles long to irrigate 132,000 acres. A net revenue of Rs. 8,33,000 is anticipated and the cost (to be revised) is estimated at 197 lakhs of rupees.

Increase in sugarcane.

The construction of large protective irrigation works with a perennial supply of water has given a great impetus to sugarcane

cultivation in the Deccan. The total area sown with this crop during the year under review was about 25,000 acres and the yield therefrom was valued at 114½ lakhs of rupees. The sugarcane industry, in addition to giving large profits to the cultivators, has a high protective value, inasmuch as it affords employment for a large number of persons from neighbouring villages, in times of scarcity. There is undoubtedly a great future for an indigenous sugar industry in a country in which the demand is far in excess of the local supply. The formation of sugar refining companies controlling large areas of irrigated land would appear to be one of the means of ensuring the further development of the industry and the Government of Bombay have, at present, under their consideration experimental proposals of this nature.

(ii) *Sind.*

Description of works in Sind.

The canal systems in Sind are entirely different from those in the Deccan They are mostly very large and carry their supplies during the inundation season only. Many of them are canals which existed before the advent of British rule and which have since been improved; some of these, although classed as minor works, are among the largest in existence, as for example the Fuleli canal, rearly 1,000 miles in length with a head discharge of 12,000 cubic feet per second, and the Ghar Canal, 306 miles in length with a discharge of nearly 11,000 cubic feet per second. The general average return on the canals in Sind is 29 per cent. on minor and 7 per cent. on major works.

The Eastern Nara System and the Begari and Ghar Canals, 1850-1860.

The first system to come into operation was the Eastern Nara, consisting of the Mithrao, Thar, Hiral and Khipro Canals. Over 70 lakhs of rupees have, up-to-date, been expended upon this system, which was opened in 1854, although its principal canal, the Mithrao, was not constructed until some years later. The system depends for its supply upon the water of the Nara river, which is fed from [illegible] 858-59, known [illegible] rigated by the [illegible] returns a net revenue of over 4 lakhs of rupees. The Begari Canal and the Ghar Canal also came into operation during this decade. The former is the most important system north of Sukkur and on the right bank of the Indus; it irrigates normally over a quarter of a million acres and produces a net revenue of about 5 lakhs of rupees on a capital outlay of 24½ lakhs. The Ghar Canal, to which reference has already been made, irrigates an equal area.

Fuleli Canal, 1860-1870.

Between 1860 and 1870 the Fuleli Canal, the largest of all the Sind Canals, was opened at a cost of 20 lakhs of rupees. Nearly 425,000 acres are irrigated from this canal; owing to the position

cultivation in the Deccan. The total area sown with this crop during the year under review was about 25,000 acres and the yield therefrom was valued at 114½ lakhs of rupees. The sugarcane industry, in addition to giving large profits to the cultivators, has a high protective value, inasmuch as it affords employment for a large number of persons from neighbouring villages, in times of scarcity There is undoubtedly a great future for an indigenous sugar industry in a country in which the demand is far in excess of the local supply. The formation of sugar refining companies controlling large areas of irrigated land would appear to be one of the means of ensuring the further development of the industry and the Government of Bombay have, at present, under their consideration experimental proposals of this nature.

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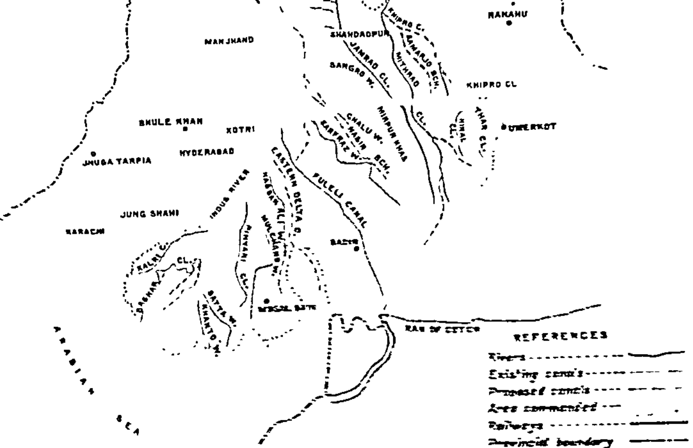
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NAWAHU
MANJHAND
SHAHDADPUR
KHIPRO C.
RAMARJO BCH.
MITHRAO
JAMRAO CL.
SANGRO W.
KHIPRO CL
BHULE KHAN
KOTRI
HYDERABAD
JHUGA TARPIA
MIRPUR KHAS
CHALU W.
NASIR
SARFRAZ W.
BCH.
CL.
NIRAL CL.
THAR CL.
UMERKOT
EASTERN DELTA C.
FULELI CANAL
INDUS RIVER
NASSAN
ALI W.
MULCHAND W.
PINYANI CL.
JUNG SHAHI
KARACHI
BADIN
KALRI C.
CL.
BAGHAR
SATTA W.
KHANTO W.
RAN OF CUTCH
ARABIAN SEA
REFERENCES
Rivers
Existing canals
Proposed canals
Area commanded
Railways
Provincial boundary

of the headworks the annual variations in the quantity of water obtainable are small and it is one of the few Sind Canals which carries an appreciable supply all the year round.

Desert and Sukkur Canals, 1870-1880.

Five more canals were added during the ten years from 1870 to 1880. Of these the two most important are the Desert Canal, costing 27 lakhs and irrigating over 200,000 acres in the northernmost part of Sind, and the Sukkur Canal, just above Sukkur, which serves a further 80,000 acres The remaining three are small canals, lying in the Hyderabad district on the left bank of the Indus.

Period of inactivity, 1880-1900.

A period of comparative inactivity followed during the 20 years from 1880 to 1900, the only work to be opened being the Unharwah Canal between the Desert and Begari Canals, with 85,000 acres of irrigation. Towards the end of the period, however, a start was made upon three new canals, the Jamrao, Mahiwah and Dad, which came into operation in the first years of the new century.

Developments since 1900.

In 1900, the Jamrao Canal came into being. This was an entirely new canal taking off from the Eastern Nara river above the Mithrao Canal, already mentioned, and, like that canal, it is assured [illegible] partly upon the Nara [illegible] Channel. The cost [illegible] 250,000 acres, and produces a net revenue of 4½ lakhs. Between 1901 and 1904 the Mahiwah, Dad and Nasrat Canals were also opened. Built at a cost of about 60 lakhs of rupees, they have added about 270,000 acres to the irrigated area in Sind. Two small canals below Kotri on the Indus, the Sattah and Hassanali Canals, also came into operation since 1900

Results obtained from Jamrao Canal.

The Jamrao Canal commands an area of nearly 800,000 acres in the Thar and Parkar and Nawabshah collectorates, a tract which was formerly inadequately served by the tails of canals taking off the Fuleli and the Indus. The area of occupied land at the date of construction was 275,000 acres out of which about 71,000 were cultivated annually; the area annually irrigated is now, as stated above, 250,000 acres. When the canal was constructed the value of the occupied land was about Rs. 20 per acre and that of the non-occupied land was practically *nil*, while to-day the average value of the land is about Rs. 45 per acre. The total increase in the value of land due to the advent of the canal is estimated at about 2½ crores of rupees.

Results obtained from the Dad and Nasrat Canals.

The Dad and Nasrat Canals, which irrigate portions of the Nawabshah collectorate, are old canals remodelled. In 1902, the former tortuous course of the Dad was straightened, remodelled and extended for a length of 87 miles, and regulators were

built at four places. Later on, a new head to the canal was excavated. These improvements have raised the level of water in the tract, [illegible]

and of land irrigated previously from Rs. 10 to Rs. 35 per acre on an average. On the Ren distributary from the Dad canal, which was excavated in 1915, the value of land has risen by 50 per cent. in three years. In the Nasrat tract, where similar improvements have been carried out, much of the land was formerly valueless, while drinking water was bad and only obtainable at a depth of from 60 to 70 feet. The water supply is now fairly good and the average value of land ranges from Rs. 20 to Rs. 50 per acre.

Progress of irrigation in Sind.

Since 1880 the total irrigation from Government works in Sind has increased from 1¼ to 3¾ million acres, and the net revenue [illegible]

acres of land.

The Sukkur Barrage project.

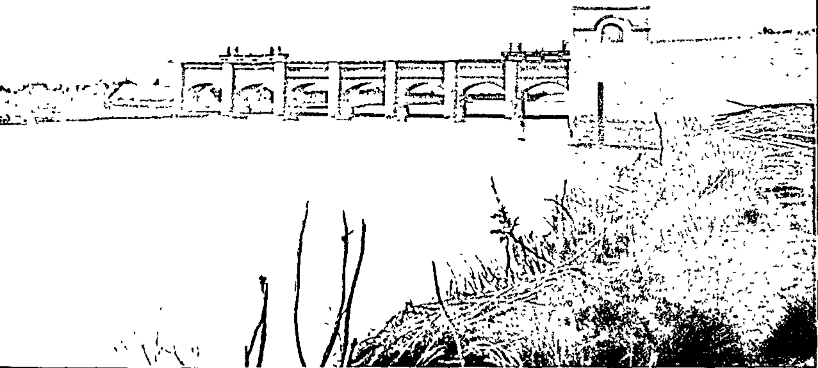
The only large work in contemplation in Sind is the Sukkur Barrage. It is realized that the development of Sind by inundation canals is now approaching its limit, and the Sukkur Barrage project, which provides for a weir across the Indus with two large perennial canals, one on each bank, has for its object the substitution, for the present rather uncertain supply of water, of a perfectly assured and ample supply, not only in the flood season, but all the year round. The problem of producing a remunerative project is a difficult one, as the works can only take credit for the increase of revenue which they produce, and the existing canals have been so much improved that the margin is somewhat small when compared with the capital outlay involved, estimated at about 1,100 lakhs of rupees; there is however no possible doubt as to the [illegible]

on special duty to make a thorough investigation of the questions involved and it is hoped that a satisfactory project will result.

Increase in irrigated area during the past 40 years.

During the past 40 years the area irrigated by productive and protective works in the Bombay Presidency has nearly sextupled. The steady increase which has taken place is shown by the following figures:—

Year.	Area irrigated in acres.
1877-78	250,000
1887-88	475,000
1897-98	871,000
1907-08	1,275,000
1917-18	1,477,000



UNDER SLUICES, JAMRAO CANAL

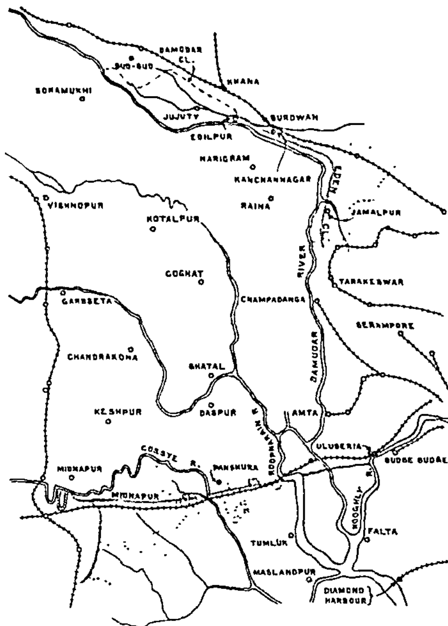
The table below shows the extensions of irrigated area which are anticipated when the principal works recently completed, under construction or under consideration are in full working order.

Anticipated extensions of irrigation.

Stage of work.	Name of work.	Area in acres.
	Sind.	
Recently completed.	Flood diversion bund to protect the Nara supply channel.	61,200
	Choi branch of the Begari canal . .	31,900
	Ren distributary from Dad canal . .	11,200
	Deccan.	
	Godavari Canals	42,000
	Sind.	
Under construction.	Mahiwah canal	145,400
	New Khipro canal and Makhi distributaries.	9,600
	Deccan.	
	Nira Right Bank canal	114,000
	Pravara canals	75,000
	Dharma canal	12,000
	Budhihal tank	5,700
	Girna Left Bank canal extension . .	3,400
	Sind.	
Estimates sanctioned.	Head distributary Hiral canal and 3rd and 7th mile Distributaries, Thar canal.	14,900
	Deccan.	
	Gokak Canal extension . . .	132,000
	Sind.	
Under consideration.	Rohri canal, Sukkur Barrage and widening the Eastern Nara Supply channel.	2,324,000
	Nasirabad canal	437,200
	Sehar canal	*68,000*
	Remodelling the lower portion of the Dad canal.	*56,500*
	Sultanwah *ex* 10th mile Begari canal .	51,000
	Gaja improvement. . . .	48,000
	Remodelling the branches and extending Dosowah *ex* Mithrao canal.	6,800
	Deccan.	
	Mutha Right Bank canal extension .	340,000
	Total . .	3,994,800

BENGAL
SKETCH MAP OF CANALS.

Scale — 1 inch = 16 miles.



REFERENCES.

Rivers - - - - - - - - - - - - -

Existing canals - - - - - - -

Area commanded - - - - - -

Proposed canals - - - - - -

Railways - - - - - - - - - - -

24,000 acres, but a new channel, with a sluice and stop dam, is now under construction with a view to improving these conditions It is also anticipated that the proposed Damodar Canal, now under consideration, will, if constructed, materially improve the financial prospects of the Eden Canal.

The areas irrigated by these two canals are shown in the following statement :— Progress of Irrigation.

Year.	Midnapore Canal.	Eden Canal.
	Acres.	Acres.
1871-72	6,029	..
1877-78	19,819	..
1887-88	65,864	..
1889-90	68,810	9,693
1897-98	72,206	24,487
1907-08	62,040	22,115
1917-18	86,786	26,439

The results of crop experiments carried out by the officers of the Department on average crops show that the average value of canal water to cultivators using the water from the Midnapore Canal is Rs. 11½ per acre, whilst the water rate charged is Rs. 2 per acre only. On the Eden Canal system the value has been calculated at Rs. 17½ per acre, whilst the water rate charged is Rs. 1-8-0 per acre only. Value of Canal Irrigation in Bengal.

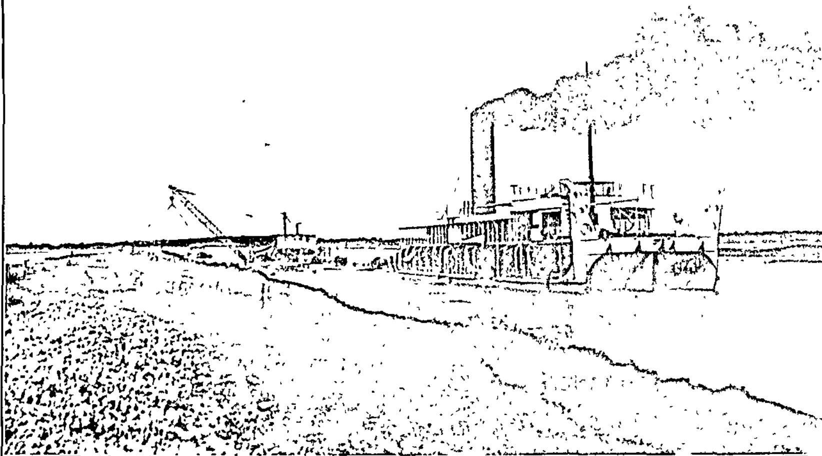
The Calcutta and Eastern Canals system provides for steamer and boat communication between Calcutta and Eastern Bengal through the Sunderbans area. The Calcutta Canals include Tolly's Nala, the Circular and New Cut Canals, the Kristopur Canal and the canalized Bangore Khal. The Eastern Canals extend from Dhappa to Barisal and consist of a series of cross tidal creeks and artificial cuts, running from west to east and connecting the natural drainage lines of the Ganges Delta which run north and south. From 1855 to 1886 the management of the Calcutta Canals vested in the Commissioner of the Presidency Division, but it was transferred, in the latter year, to the Public Works Department. The system, which is not covered by any complete sanctioned estimate, comprises a total length of channel of 1,181 miles. Navigation Systems of Bengal. The Calcutta and Eastern Canals.

A sum of Rs. 2,11,722 was expended during the year as debitable to the capital account of these canals. This expenditure was mainly incurred on the improvement by widening and deepening Work done during 1917-18 on the Calcutta and Eastern Canals.

of the Gabkhan Bharani Khal from Chowkeegatta to Jhalakati. This khal is on the main steamer route from Khulna to Barisal and serves as an alternative route to the Angeria Creek. Khulna and Barisal are the headquarter stations of the districts of Khulna and Backerganj, and, as there is no railway communication with Backerganj, the maintenance of a suitable navigable channel for steamers on this main line of communications is essential. The Angeria Creek, although periodically dredged, silts up again very quickly; it is anticipated that this new Bharani khal will maintain itself free of silt. The work was taken up in 1914-15 and will be completed in the year 1918-19 to a bed width of 175 feet An extraordinary feature of this khal is the nature of the subsoil underlying its bed. The soil is of a black peaty nature, and the roots of forest trees and hard peat are frequently met with, choking the suction head of the dredger and thus causing numerous delays and some break-downs of machinery. The expenditure on this work up to end of March 1918 amounted to Rs 6,26,431 and it is anticipated that the total cost for works only will be Rs 7,48,739. It will be necessary to widen the khal at a future date to a bed width of 250 feet.

Madaripur Bil Canal.

The Madaripur Bil Canal, which connects the Madhumati and Kumar rivers in the district of Faridpur, was originally a part of the Calcutta and Eastern Canals system. In the year 1895-96 its improvement by deepening and widening was taken in hand with a view to shorten the distance for inland steamer traffic, and it has now the status of a separate project, upon which 40 lakhs of rupees had been expended up to the end of 1917-18 The canal is 21 miles long and passes through the centre of the great Madaripur Bil in a north-easterly direction; when the Ganges and Brahmaputra rise in flood, a general spill takes place into the bil from the Madhumati and Kumar rivers. The water entering the bil from the former river through the western entrance caused a heavy deposit of silt in the mouth, due to the velocity being checked, and large sums, which in the year 1914-15 amounted to 2¼ lakhs of rupees, have been spent in an endeavour to keep open a navigable channel with powerful suction dredgers. Enquiries proved that river levels in the Kumar are always above those in the Madhumati and it was therefore decided to control the water levels in the [illegible] on the south bank, [illegible] induced which would [illegible] canal; these works were completed in the year 1916-17 and have proved a complete success. The Kumar deposits its silt in the bil and a stream of clear water now issues into the Madhumati, with the result that no further silt trouble has been experienced; the tollage receipts have in consequence risen from 67,000 rupees in 1914-15



DREDGER 'FOYERS' AT WORK IN THE MADARIPUR BHIL ROUTE.

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to over 3½ lakhs of rupees in 1917-18 and maintenance charges have been reduced to about 90,000 rupees. These works paid a return of 7 per cent. in 1916-17 and 6½ per cent. in 1917-18. The canal forms a short route to Eastern Bengal and Assam, the distance being 115 miles less than by the Barisal route to the south, in the year under review, 5,634 steamers and flats used this route transporting 390 lakhs of maunds of cargo.

Hijili Tidal Canal.

The Hijili Tidal Canal, in conjunction with the Orissa Coast Canal, affords inland boat communication between Bengal and Orissa. It was commenced in 1868 and completed in 1873, and, previous to the opening of the Bengal Nagpur Railway, was the only inland route by which supplies of food could be conveyed into Orissa in time of famine

General improvement of Inland waterways.

In addition to the maintenance of these canals a considerable amount of work is done by the Bengal Public Works Department in connection with the improvement of inland waterways to provide better facilities for inland steamer and boat traffic, and two suction dredgers are kept constantly at work, the combined output of which amounts to 75,000 c ft. per hour, these dredgers are engaged in removing shoals and spits on the steamer routes, widening and deepening existing channels and providing shorter river to river connections. The amount of work offering for this class of excavator is more than the present plant can cope with, and the want of a larger fleet is much felt. In addition to this class of work a navigable channel of 200 miles in length on the Ganges is maintained. This river, between Rajmahal and Goalundo, presents many difficulties to navigation owing to the formation of shoals, and it not unfrequently happens that a flat or steamer runs aground and has to be lightened by removal of cargo before she can be floated off, which not only entails delay but may mean an entire wreck. Government consequently undertakes to keep open each year a navigable channel for steamers and flats of six feet draft, and very careful watching and immediate action are necessary, as unless shoal formation is rapidly checked the subsequent difficulties are considerably increased.

The Joint Steamer Companies (India General Navigation and Railway Company and the River Steam Navigation Company) carried out this work on behalf of Government during the year under review, owing to the dearth of officers of the Department on account of the war.

Flood Embankments.

The Bengal Public Works Department are further responsible for the maintenance of about 1,350 miles of embankments, which protect some 6,000 square miles of country from inundation during floods and high tides. They date from the very earliest times

in the history of Bengal and have been maintained by Government since the Permanent Settlement.

Projects under consideration. The Damodar Canal.

The only irrigation project now under consideration is that for the Damodar Canal. It is proposed to utilize the water of the Damodar for the irrigation of certain tracts in the Burdwan district and it is anticipated that about 105,000 acres will be irrigated. The rough estimated cost of the project is 60 lakhs of rupees. The scheme also provides for an increased supply for the irrigation of the area commanded by the Eden Canal, where the area under irrigation will be increased to 45,000 acres, while that Canal will be restored to its original scope of sanitary improvement and the supply of good drinking water.

Prospects of extension of irrigation in Bengal.

The table below shows the prospects of extending irrigation in the Presidency as compared with the areas already irrigated—

——	Name of Canal.	Area.
Areas already irrigated	Midnapur	86,800
	Eden	26,400
	Total	113,200
Additional areas from projects under consideration.	Damodar	105,000
	Eden	17,600
	Total	122,600

The Grand Trunk Canal.

The largest navigation project under consideration is that for the construction of the Grand Trunk Canal, to connect Calcutta with the main river system of Eastern Bengal for the purposes of inland steamer traffic. The southern steamer route across the Sunderbuns is threatened with closure on account of deterioration at the western end and many of the old rivers have been permanently [illegible]

rupees. The canal will consist of a locked length of 22½ miles between the Hooghli at Calcutta and the Kulti Gong, and will give access to a group of rivers at the head of the Sunderbans area at present unused by inland steamers, shortening the distance between Calcutta and Khulna by 136 miles, or more than half that of the present Sunderbans steamer route In the vicinity of Calcutta, inland harbours will be provided so that vessels can be

turned round quickly and facilities for the expeditious handling of cargo will be supplied; both the canal and harbours will be excavated by suction dredgers which will raise the land and thereby render it fit for occupation for the purpose of industries and residences. The detailed scheme was under the consideration of the local Government during the year, and public bodies interested were consulted and asked to put forward their views on the alignment and scope of the canal.

Widening of Madaripur Bil Canal.

The question of widening the Madaripur Bil Canal, which has been described above, has been under consideration for some time past. The present width of the canal varies between 150 and 170 feet, but it is periodically constricted to 120 feet at the two ends owing to the formation of spits. It is proposed to give the canal a uniform width of 320 feet in order to allow two steamers, each with two flats in tow, to pass abreast. The cost of such widening would amount to 17 lakhs of rupees. The traffic through the Bil route has increased enormously since the construction of the embankment and sluices previously referred to, and congestion and delay in navigation have become manifest.

General improvement of inland waterways.

In the matter of general improvement of inland waterways much yet remains to be done. The Nadia rivers, comprising the Bhagirathi, the Jalangi and the Mathabhanga rivers, were, in the past, main routes of navigation during the monsoon, but owing to their rapid deterioration they have been partially abandoned. [illegible]

considerable decrease in the fresh water supply to the Hughli. On certain other rivers, the Dhaleswari, the Buriganga and the Gorai, deterioration has taken place to such an extent that navigation has become impossible during the dry months, except for steamers and boats of very shallow draft, and this deterioration having now been retarded by means of dredging and other operations, it is the hope of the local Government to restore eventually navigable conditions during the greater part of the year. The deterioration which has taken place in these direct river connections between Calcutta and the Ganges is a matter of grave concern, not only from the point of view of navigation but from that of sanitation also. In October 1917 an Executive Engineer was placed on special duty to enquire into the possibility of the improvement of navigation and drainage conditions in the area enclosed by the Padma on the south, the Jamuna on the west, the Dhaleswari on the north, and the Meghna on the east. Much valuable information

CHAPTER VI.

UNITED PROVINCES.

Eastern Jumna **Canal, 1830.**

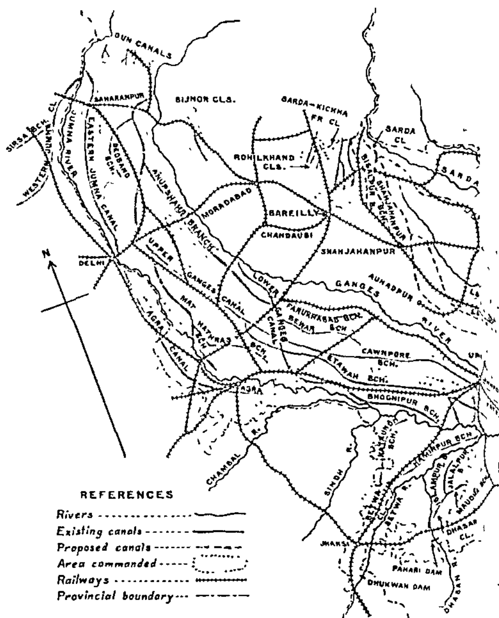
The introduction of state irrigation into the United Province may be said to have been established in 1830 when the Easter Jumna Canal, at that time known as the Doab Canal, was opened The origin of the canal is lost in the mist of history, but it is believe to have been built by one of the Emperors of the Moghul dynasty In 1822 a survey of the canal was made with a view to re-opening it construction was commenced at the close of that year and it wa opened for irrigation in 1830 The Eastern Jumna is still the mos remunerative canal in the United Provinces, it irrigated an are of 355,000 acres in 1913-14, the highest on record, and gives steady return of over 25 per cent on a capital outlay of 52 lakhs.

The Ganges Canal, 1854.

The first great landmark in the history of the irrigation of th province was the opening of the Ganges Canal in 1854. Fo boldness of conception, breadth of imagination and completenes in detail Sir Proby Cautley's monumental work is still almost unrivalled in India. Without any previous experience of irrigation works on anything like the same scale to guide him, he designed and constructed a canal system which is still one of the largest in the world, and in which the light of subsequent experience has disclosed but few faults. Irrigation commenced in 1855, although the distributary systems were very incomplete, and operations were greatly hampered by the Mutiny; nevertheless it steadily developed and in the famine of 1861-62 the full supply for which the canal was designed was admitted for the first time. It was then discovered that the bed-slope was excessive, the resulting high velocity of flow causing considerable erosion of the bed and banks of the canal, and serious scour below the falls, to remedy which defect an estimate amounting to 36½ lakhs of rupees was sanctioned and the work taken in hand in 1865. The total capital expenditure on the Ganges Canal now stands at 392 lakhs upon which a net return of about 10 per cent. is realized; in 1915-16, a year of high demand, it irrigated 1,262,000 acres, the highest on record.

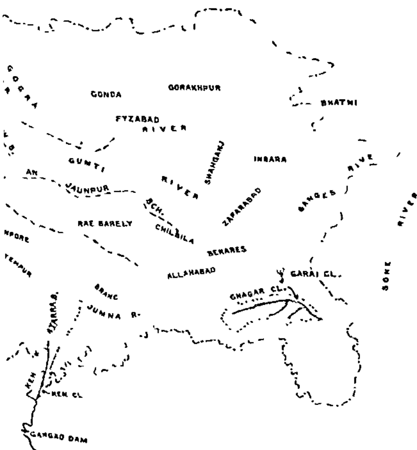
Results of introduction of irrigation into Ganges-Jumna Doab.

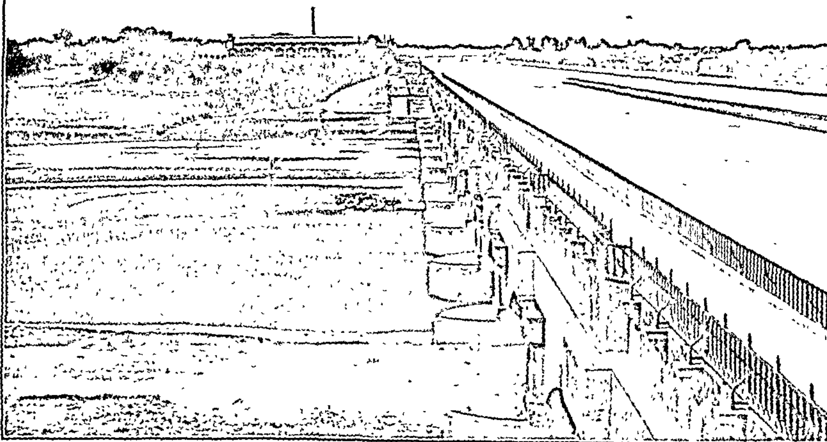
The increase in prosperity which has been experienced in the Ganges-Jumna Doab owing to the introduction of irrigation has been very marked. Taking the Muzaffarnagar district, which is irrigated by the Deoband Branch of the Ganges Canal constructed in 1877-78, as an example, the Settlement officer in 1874 reported that the most striking feature of the tract was the want of means


DUN CANALS
SAHARANPUR
BIJNOR CLS.
SARDA-KICHHA FR CL
SARDA CL
ROHILKHAND CLS.
SARDA
SIRSA BCH. CL
WESTERN JUMNA CL
JUMNA RIVER
EASTERN JUMNA CANAL
DEOBAND BCH.
ANUPSHAHR BRANCH
MORADABAD
BAREILLY
CHANDAUSI
SHAHJAHANPUR
N
DELHI
UPPER GANGES CANAL
LOWER GANGES CANAL
GANGES
AURADPUR
RIVER
MAT BCH.
HATHRAS BCH.
FARUKHABAD BCH.
BEWAR BCH.
AGRA CANAL
CAWNPORE BCH.
ETAWAH BCH.
AGRA
BHOGNIPUR BCH.
CHAMBAL R.
SINDH R.
HAMIRPUR BCH.
BETWA CL.
BETWA R.
JHANSI
DHASAN CL.
PAHARI DAM
DHUKWAN DAM
DHASAN R.
REFERENCES
Rivers
Existing canals
Proposed canals
Area commanded
Railways
Provincial boundary

UNITED PROVINCES
SKETCH MAP OF CANALS

Scale—1 inch = 64 miles





SOLANI AQUEDUCT, UPPER GANGES CANAL.

of irrigation and the prevalence of sand, and he went on to remark that, in a year of drought, the fertility of the river valleys formed a pleasant relief to the eye wearied with the view of scanty crops in an unirrigated upland. All this is now changed, for many years the upland villages have been supplied with canal irrigation, and year by year fresh estates are added to the list until now only a few remain which are not watered from this source The cultivated area in the district has increased by 42,500 acres or 19 per cent since the settlement of 1874, while the irrigated area has increased by over 100,000 acres or 467 per cent.

The effect which the substitution of canal for well irrigation has had in improving the standard of cultivation tends to make the change wrought in the conditions of the parganas, previously irrigated from wells, as great as in those in which irrigation was formerly unknown; for the substitution of canal flow irrigation for irrigation from wells has set free an amount of labour equivalent to a substantial addition to the population, and a large accession to the number of cattle employed in agricultural operations. In the Khatauli pargana of the Muzaffarnagar district, for example, the opening of the canal has led to the substitution of canal flow irrigation for the more laborious watering from wells in the case of 6,950 acres. It may be assumed that the average number of waterings is two, so that the labour of men and cattle required to irrigate 6,950 acres twice has been saved in this pargana alone by the substitution of flow irrigation from the canal for that from wells. The bullock labour thus saved has been sufficient to provide for the cultivation of larger areas of sugarcane and for the ploughing of the greater part of the increased cultivation.

The value of land has also risen greatly throughout the tract. A reference to the old land acquisition records shows that the price paid for land when the Deoband Branch was constructed in 1877-78 was from Rs 30 to Rs. 80 per acre, whilst when remodelling the branch in 1903 the price paid was from Rs 88 to Rs. 146 per acre, the value of the land having thus increased to 212 per cent. of its former value.

In addition to the practical prevention of famine in seasons of drought, the canal has had a marked influence in promoting arboriculture Valuable trees flourish along the canal and the example so successfully shown has been followed by the proprietary cultivating bodies throughout the irrigated tract. The canal has also had a marked influence for good on the character of the population. The industrious classes have been enabled to improve heir style of cultivation and to extend the areas of the best crops,

while certain idle and less respectable tribes have discovered that cultivation can be made to pay. The extension of cultivation, the increasing certainty of a fair return in agriculture and the reclamation of many idle classes thus figure prominently among the benefits due to the canal.

Dun, Rohilkhand and Bijnor Canals, 1840-1870.

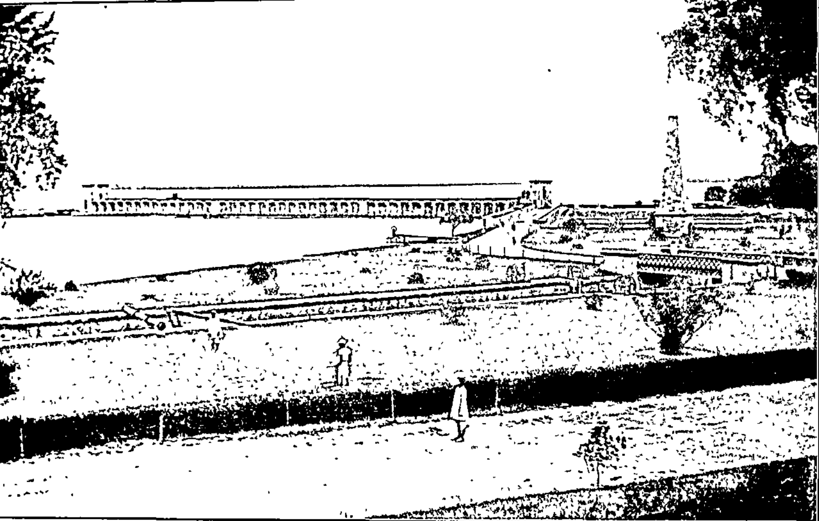
Between 1840 and 1863 a number of small canals were either built or taken over by Government. The Dun canals, in the Debra Dun district, were opened for irrigation during this period; they comprise six small canals which irrigate about 20,000 acres. The two Bijnor canals were constructed between 1840 and 1850 to irrigate 31,000 acres in the Bijnor district, and in 1843 the State took over the Rohilkhand canals, consisting of four systems in the submontane Tarai, which irrigate to-day upwards of 200,000 acres.

Agra and Lower Ganges Canals, 1870-1880.

The decade commencing in 1870 is noteworthy for the opening of two major productive works, the Agra Canal coming into operation in 1874 and the Lower Ganges Canal in 1878. The former canal takes off from the Jumna near Delhi, it has cost up to date 123 lakhs of rupees, and irrigates over a quarter of a million acres in the trans-Jumna tract. The development of irrigation has, however, taken place somewhat slowly and its arrears of interest were not cleared off until 1915-16. The Lower Ganges Canal has its headworks at Narora, 140 miles below those of the Ganges Canal at Hardwar, and was designed to irrigate the lower portion of the watershed between the Ganges and the Jumna. A great set-back to irrigation from this canal was experienced in 1884, when the aqueduct, 33 miles from its head, which carries the canal over the Kali Nadi, was breached. It was temporarily repaired but in the following year a flood of unprecedented magnitude, estimated at 140,000 cubic feet per second, due to a fall of rain of 20 inches in 24 hours, completely destroyed the work. It was replaced by the present aqueduct, which is one of the finest works in India and is the largest aqueduct in the world. The total cost of the Lower Ganges system amounts to 417 lakhs. It is a sound productive work and irrigates up to 1,200,000 acres.

Benefits accruing from construction of Lower Ganges Canal.

As in the case of the Upper Ganges Canal, the introduction of irrigation from the Lower Ganges Canal has brought vast benefits in its train. The cultivated area has increased, more valuable crops have, to a large extent, ousted the inferior ones previously grown, and districts which formerly suffered severely in every year of drought are now protected and secure. The change which has taken place is well described by the Settlement officer in the last Settlement report of the Cawnpore district. "If," he wrote,



UNDER SLUICES AND HEAD REGULATOR, LOWER GANGES CANAL.

"the Government felt inclined to defend either its policy in digging canals or its reputation against those who charge it with being the author of famine, it could not have accomplished both its objects more easily or more emphatically than by sending its critics on a short tour through the Sengar Jumna Doab during the cold weather of 1903-04. This tract was divided more or less into two strips, one consisting of dry estates unchanged from time immemorial and the other of estates provided with canal water for the first time within the last two decades In both cases the rainfall had failed entirely, with the result that, in the former, mile upon mile of good arable land lay bare of any vestige of a crop, whereas in the latter an exuberant harvest met the eye in every direction; yet 20 years

from Rs. 13 to Rs. 68 per acre, since the branch was constructed.

In 1885 the first protective work in the United Provinces, the Betwa Canal, was opened. The tract of country commanded consists of a triangular space of about 1,500 square miles between the Betwa, Pahuj and Jumna rivers, the greater portion lying in the Jalaun district. The headworks of the canal are situated at Paricha, about 17 miles from Jhansi, where a massive masonry weir extends across the rocky bed of the river and forms a reservoir of 3,000 million cubic feet capacity. As a protective work the system has proved

Betwa Canal, 1880-1885.

The completion of the Betwa Canal was followed by a period of nearly 20 years during which little new construction was undertaken, the only works of importance being the Fatehpur branch of the Lower Ganges Canal, which was completed in 1902 at a cost of 39 lakhs of rupees, and the extension of the Mat branch of the Ganges Canal, which was completed in 1905 The Irrigation Commission

during the

ially in the

Progress from 1885-1905.

Only one new productive canal, the Garai Canal in Mirzapur, has been constructed since the Lower Ganges Canal came into operation, but numerous additions have been made to the distributary systems of the existing canals. The most important extensions which have been executed since 1905 are the Fatehpur-Sikri

Productive works since 1905.

distributary extension, the remodelling and extension of the Aring distributary system and the construction of the Bukhrari distributary, all on the Agra Canal, and the Hathras branch of the Ganges Canal which was opened in 1912 The cost of construction of the last named amounted to 16½ lakhs of rupees, and it is estimated that an area of 110,000 acres will eventually be irrigated from it.

The Garai Canal was completed during the year under review. It consists of an upper storage reservoir to hold 1,000 million cubic feet of water and canals taking out from either side of a pick-up dam lower down These canals command an area of 51,500 acres of which 20,000 will be irrigated yearly.

Protective works since 1905. The Ken Canal.

It is, however, in the construction of protective works that the greatest advance has been made. In 1906 the Ken Canal, with its headworks at Bariarpur, was opened for the irrigation of the Banda district The weir, which is built of large blocks of gneiss, has a length of 1,080 feet and a maximum height of 26 feet above the solid rock on which it is founded, and its crest is fitted with steel back-strut gates, 10 feet long and 8 feet high, which can be dropped from the crest or, in case of emergency, from a subway which runs throughout the length of the weir The canal head takes off at right angles to the weir In the head reach, for a length of seven furlongs, the canal crosses a rock ridge through which it was at first proposed to construct a tunnel, but an open cutting was eventually adopted This proved a tedious and difficult work, the rock being very hard in many places, and the depth of the cutting as much as 60 feet Labour was difficult to obtain, especially after two outbreaks of cholera which frightened the labourers away. Down to mile 19 the canal passes through very rough broken country interspersed with rocky hills, and crosses all the drainages leading to the Ken river; the alignment through this reach was particularly difficult, but it was most successfully negotiated. The main canal is designed to carry a maximum supply of 1,000 cubic feet per second with 7 feet water depth, the bed being 55 feet wide.

The Gangao dam.

Soon after the opening of the canal it became apparent that the reservoir at Bariarpur was insufficient for its needs, and in 1910 work was commenced on a dam higher up the river at Gangao, where a supplementary reservoir of 4,000 million cubic feet capacity has been constructed. The work was completed at the end of the year 1916-17, the total capital cost of the Ken canal system now [illegible]
now ·
Duri
had
early stages of the work it was very disheartening to find the people



GENERAL VIEW, DHUKWAN WEIR, BETWA RIVER.

for whose benefit the work was being constructed refusing to assist A succession of excellent harvests had been reaped in Bundelkhand from the commencement of the work till the monsoon of 1913 The people were well off, had good stocks of grain, and consequently refused to work. Labour had to be imported with liberal advances, and not infrequently the men absconded after working a few days. Progress was thus retarded, but by dint of perseverance the dam has been successfully completed.

The Dhukwan Weir.

The necessity for additional storage on the Betwa Canal had also made itself felt, and a subsidiary reservoir 25 miles above Paricha, at Dhukwan, was completed in 1911 at a cost of 22½ lakhs of rupees, to store nearly 4,000 million cubic feet of water, or sufficient to increase the irrigating capacity of the canal by 90,000 acres in a year of drought. The dam, which is three quarters of a mile long, is 57 feet high, and the crest is fitted with 8 feet falling shutters. As a natural sequence to the provision of extra storage the question of remodelling the channels was taken up. The Hamirpur Branch, which is 83 miles long, and a large distributary from it, the Jalaun distributary, were remodelled Several minors were also remodelled to enable them to carry larger supplies, and further minors were built to carry irrigation into new tracts, the efficiency of the Betwa canal system being thus considerably increased.

The Dhasan, Pahuj-Garhmau and Ghori Canals.

The Dhasan Canal, which provides irrigation in the Hamirpur district, was opened in 1910. It is fed from two reservoirs on the Dhasan river, has cost half a crore of rupees up to date and is designed to irrigate 75,000 acres in a normal year, and 100,000 acres in a year of drought. The Pahuj and Garhmau canals, two small canals constructed to irrigate 18,500 acres in the northern portion of the Jhansi district, came into operation in 1911, and the small Ghori canal in Mirzapur in 1916.

The Ghaggar Canal.

The Ghaggar Canal in the Mirzapur district was completed during the year under review. A masonry dam, 65 feet high, with a massive earthen embankment over 3 miles long, forms a reservoir to contain 5,000 million cubic feet of water. This reservoir is filled partly from the Ghaggar river, and partly by means of a cut from the Karamnasa river. The main canal, with a discharge of 570 cubic feet per second, commands an area of 253,000 acres, of which 60,000 will be irrigated yearly. In addition to this, a canal taking out of the Karamnasa feeder cut will irrigate some 7,000 acres. The total cost of this scheme has been nearly 40 lakhs. The works were commenced in the cold weather of 1912-13, and construction has been carried on in the face of great difficulties, and frequently under the most trying circumstances. The Ghaggar dam and Karamnasa weir are situated some 60 to 70 miles from the

nearest railway, in a most inaccessible part of the country where there were no communications, where local labour was impossible to obtain, and, even when labour was imported, the unhealthiness and wild nature of the place caused the labourers to abscond. There were no metalled roads and carts were unknown in that part of the country when construction began. Drinking water in many places was very hard to procure, especially during the hot weather months when it often had to be carried for miles. In addition to these difficulties, a sudden big flood in the Karamnasa river in 1915, before the rains had broken, outflanked the weir and scoured a large hole in the bank. To overcome this scarcity of labour, a steam navvy and other labour-saving appliances were utilized. The cost of excavation with the steam navvy proved higher than was anticipated, as it was impossible to maintain the full steam pressure with wood fuel, but the navvy proved useful as the work could not have been carried through without mechanical power. There was also great difficulty in obtaining contractors In spite of all these disabilities, however, construction was steadily advanced, and a small quantity of water was available for irrigation in the cold weather of 1916-17, when about 4,000 acres were irrigated.

The Majhgawan Tank and Canal.

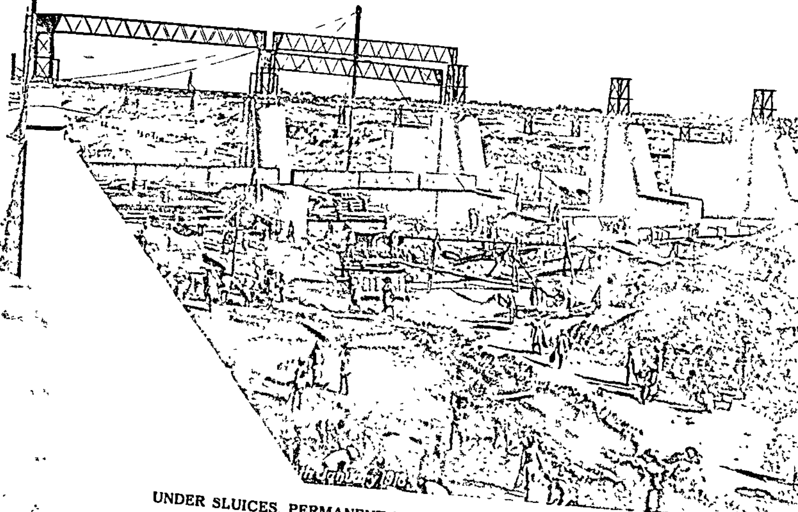
The Majhgawan Tank and canal, a small but useful work in pargana Kulpahar, Hamirpur district, was completed in 1917-18 This scheme provided for the restoration of an old bund. The reservoir thus formed stores 944 million cubic feet of water and 5,000 acres will be irrigated from the small canal system.

Minor works since 1905.

In addition to the above, the construction of tanks and embankments in Bundelkhand has been receiving the constant attention of Government since 1905. A special tanks division was formed in that year, but by 1910 the works had spread over so wide an area that it was impossible for one division to look after them and they were divided among five existing divisions. The total expenditure incurred on tanks and embankments, quite outside any of the canal systems, exceeds 20 lakhs of rupees. In addition to these tanks a small canal, the Sukhra canal in Mirzapur, financed by the local Government, has recently been opened.

Enhancement of land values due to irrigation works in Bundelkhand.

Since the introduction of canal irrigation into Bundelkhand the value of land has risen considerably. There are other influences at work apart from the canals, but the latter are by far the most important factor in this increase. It may be said that since the introduction of canal irrigation, land values of all classes of soil have risen by 75 per cent. On the Majhgawan Tank system values have gone up 127 per cent. The increase of rent on land submerged by the Kumhariya bund is 144 per cent., and by the Goondi bund 200



UNDER SLUICES, PERMANENT HEADWORKS, GANGES CANAL
(UNDER CONSTRUCTION

per cent., while in many villages watered by the Dhasan canal values have gone up 100 per cent. and in one case 300 per cent.

New headworks for Upper Ganges Canal.

The only productive work under construction at the end of the year was the new permanent headworks for the Ganges Canal at Hardwar. Hitherto the diversion of the river to the canal head has been effected by means of temporary weirs which are built annually when the river is low and are washed away when it rises in the monsoon. This method of control has long proved unsatisfactory, since the canal supply is generally inadequate when there is a long break in the rains or in case of an early winter demand. The new headworks, which are estimated to cost about 40 lakhs of rupees, will give complete control over the river supply at all seasons of the year. The work is also interesting as being the first great irrigation work in the United Provinces where labour saving machinery has been used on a large scale. A hydro-electric power station was built on the Ganges canal at Bahadrabad, 10 miles from the site of the headworks, where a fall of 19 feet is available, and whence current is conveyed to the weir site; stone crushers, concrete mixers, mortar mills, cranes and pumps are among the various forms of machinery operated by the power thus obtained.

Protective works under construction.

Construction was in progress upon one small protective work, the Barwar lake and canal. This scheme provides protection for a large portion of the Garotha pargana of the Jhansi district, by means of irrigation from a large reservoir formed by a dam across the Lidwa nadi The commanded area is nearly 26,000 acres, of which about 7,000 acres will be irrigated.

The Sarda Canal.

Numerous projects have been prepared for canals from the Sarda river, dating from 1870, but until recently the taluqdars, the large landholders of Oudh, have strenuously opposed the introduction of canal irrigation. Consequently the Irrigation Commission, while refusing to recognise that any objections had been urged against the canal which could not with equal force have been urged against the Ganges Canals, suggested an alternative method of utilizing the Sarda water by diverting it across the drainage of the country, supplementing the supplies of the Rohilkhand Canals and picking up a considerable area of new irrigation on the way, and discharging the surplus into the Ganges above the head of the Lower Ganges Canal. At present the latter receives part of its supply direct from the river and part through the Ganges Canal; the Sarda water would not only have permitted extensions of irrigation on the lower canal but would have rendered it independent of the upper, a portion of the water thus freed being utilized on the Ganges Canal itself, a portion being passed into the Agra Canal, while a third portion was to be passed by means of a second feeder channel

into the Eastern Jumna Canal. The result would have been that a smaller share of the water in the Jumna would have been required *for the latter and the surplus* was to be used on the Western Jumna Canal in the Punjab, to extend irrigation in Rohtak and Hissar. The project, which was estimated in detail to cost 6¾ crores of rupees, and to give a return of 7 per cent., was one of extraordinary engineering difficulty. The main feeder line, 159 miles long, crossed 65 rivers and drainages, and in flood time more than a million cubic feet of water per second had to be passed over, under or across the canal. The scheme involved negotiations with the Punjab and with the Rampur State, and while these were in progress a change of attitude became evident among the landholders of Oudh, which resulted in a memorial being presented to the local Government praying that the Sarda water might not be diverted, but might be utilized *in the tract to which it belonged geographically. At the same time* it was found that the Bhakra *Dam project in the Punjab* was likely to prove feasible and to provide a better supply of water for the Western Jumna tract than could be obtained from the Sarda scheme. As a result an alternative estimate has been prepared for a Sarda Canal for Oudh. One branch will run westward across the Tarai to supplement the supply in and admit of exten- [illegible] will [illegible] way, [illegible] the western branch bifurcates north of Hardoi, the two portions terminating at the boundary of the Allahabad and Jaunpur districts. The whole system entails the construction of 5,000 miles of channels, is designed to irrigate nearly 2¼ million acres and is expected to yield eventually a return of 8½ per cent. on a capital expenditure of 857 lakhs of rupees.

Projects for protective works under consideration.

A large number of projects for protective works have been prepared or are under consideration. Four large tank projects, for the Aunjhar and Bhatkhara and Jaiwanti Tanks in the Banda district, and for the Raipura Tank in the Hamirpur district, have been sanctioned, but they are held in abeyance pending allotment of funds. It is hoped that the construction of these works will be commenced next year. The Pachwara Lake system has been sanc- [illegible] Amongst projects [illegible] 27,000 acres of [illegible] cost of 15½ lakhs of rupees, the Paisuni Canal, with a reservoir of 3,400 million cubic feet, estimated to cost 29 lakhs of rupees and to irrigate 38,000 acres in Banda, the Urmal Canal to irrigate 77,000 acres in Hamirpur and Banda at a cost of 25 lakhs of rupees, and the Ohan Canal also in the Banda district, with an estimated cost of 12 lakhs of rupees and an anticipated area of 15,000 acres. Projects have also

been framed for a third reservoir on the Dhasan, to store nearly 8,000 million cubic feet of water, and for an extension of the Dhasan Canal, the cost of the works amounting to 63 lakhs of rupees and the additional area anticipated being 60,000 acres. An estimate has also been prepared for a third reservoir on the Betwa river some 15 miles above the Dhukwan weir An excellent site has been found where 11,200 million cubic feet of water can be stored.

Minor works under consideration.

A large amount of work still remains to be done in regard to the protection of precarious areas by small tanks. 18 estimates, totalling 16 lakhs of rupees, have been sanctioned for such works in the Agra, Hamirpur, Jhansi and Allahabad districts, which will be constructed when funds are available, and 51 estimates have been prepared for tanks and terracing in Azamgarh, Jaunpur and Partabgarh.

Increase in irrigated area during the past half century.

During the last fifty years the area irrigated by the Productive Canals in the United Provinces has been more than quadrupled; and the Protective Canals also show a steady development of the area irrigated from them. The increase is shown in the table below:—

Year.	Protective.	Productive.	Total.
1867-68 . . .	..	716,000	716,000
1877-78 . . .	..	1,415,378	1,415,378
1887-88 . . .	24,135	1,373,646	1,397,781
1897-98 . . .	48,994	2,296,492	2,345,486
1907-08 . . .	162,990	3,187,864	3,350,854
1917-18 . . .	199,831	2,871,087	3,070,918

The apparent falling off in the last decade is due to the fact that the year 1907-08 was one of exceptional drought during which the demand for canal water was most intense throughout, the area irrigated in kharif being the highest on record and that irrigated in rabi having been only twice exceeded.

Progress anticipated.

The table below shows the extensions of irrigated area which are anticipated when the principal works recently completed

under construction or under consideration are in full working order :—

Stage of work.	Name of work.	Area in acres.
Completed . .	Gangao dam	1,25,200
	Sukhra Canal	3,500
	Ghori Canal	8,250
	Garai Canal	25,000
	Ghagar Canal	67,000
Under construction .	Ganges canal headworks . .	86,166
	Barwar lake and canal . .	7,200
Sanctioned . .	Aunjhar tank	2,100
	Bhatkhara tank	5,783
	Jaiwanti tank	4,500
	Raipura tank	3,100
Under consideration .	Sarda Canal	2,145,224
	Belan Canal	27,000
	Kurra reservoir and Trans-Barma extension of Dhasan Canal	59,750
	Paisuni Canal	38,010
	Urmel Canal	76,700
	Ohan Canal	15,183
	Bela Sagar Tank	10,074
	Third reservoir on Betwa river at Kaprar.	49,400
	TOTAL . .	2,759,145

The total area irrigated in 1913-14 in the United Provinces was 3,450,000 acres and the above figures show that an increase in this area of about 80 per cent. is contemplated.

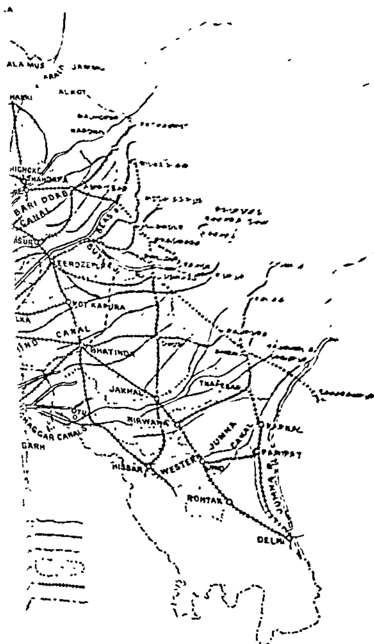
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	Barwar lake and canal . .	7,200
Sanctioned . .	Aunjhar tank . . .	2,100
	Bhatkhara tank . . .	5,788
	Jaiwanti tank . . .	4,500
	Raipura tank . . .	3,100
Under consideration	Sarda Canal	2,145,224
	Belan Canal	27,000
	[illegible]	59,750
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PUNJAB
SKETCH MAP OF CANALS

Scale—1 inch = 64 miles



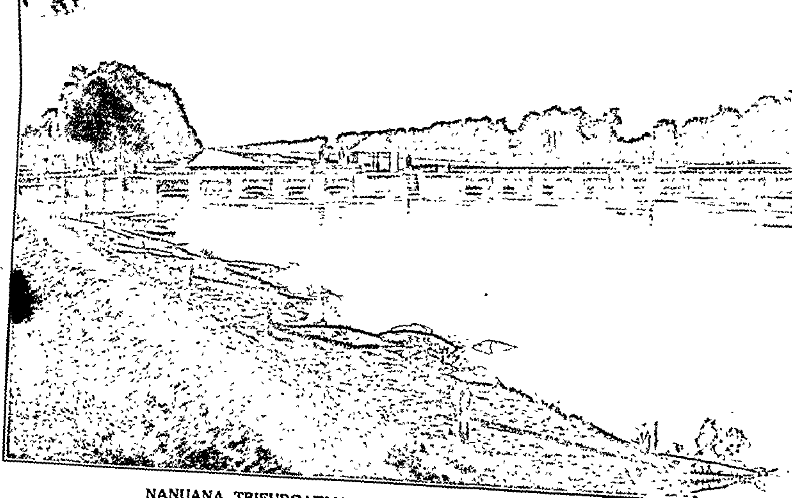
Upper Bari Doab Canal, 1846-1861.

After the annexation of the Punjab in 1846 the need to provide occupation for the disbanded Sikh soldiery caused Lieutenant Colonel Napier (afterwards Lord Napier of Magdala), then Chief Engineer, Punjab, to take up the question of extending irrigation into the upper portion of the Bari Doab, between the Ravi and Beas rivers. The project was prepared by Lieutenant Dyas of the Royal Engineers, but the Multan war delayed the commencement of the scheme until 1851, so that irrigation did not begin until 1861 The old canal of Nawab Ali Mardan Khan was absorbed in the new [illegible] feet of water [illegible] more than d [illegible] date, a capital outlay of 218 lakhs, upon which it returns from 12 to 17 per cent, irrigating over one million acres in the year under review The question of the extension of irrigation from inundation canals was also taken in hand at about this time, the Indus system being reopened in 1850 and the Upper Sutlej system brought into operation in 1855.

Remodelling of Western Jumna Canal, 1870-1900.

The Western Jumna Canal came over to the Punjab in 1858. As already mentioned, it was aligned for the most part, along drainage lines and continued to irrigate in this state until 1870, with the result that large tracts of land were converted into malarious swamps In the year 1845, a Commission, consisting, of Colonel (afterwards Sir William) Baker of the Engineers and Surgeon Dempster, enquired into the connection between blocked drainage, water-logging and malaria. In 1871, Colonel Crofton, Chief Engineer, Irrigation Branch, prepared a project, estimated to cost Rs. 1,29,21,900, for the remodelling of the entire canal system, for its extension towards Sirsa, and for the construction of a dam across the river at its head at Tajawala. The Government of India recommended the whole of this project for sanction except the Sirsa Branch extension and the realignment of the main canal from Dadupur to Indri, these two portions being deferred for later consideration.

The Secretary of State sanctioned the estimates sent up by the Government of India which amounted to Rs. 72,19,210, and later on sanctioned revised estimates amounting to Rs. 73,78,039, a figure which was swelled by indirect charges to Rs. 1,01,88,202. The Sirsa Branch extension was sanctioned in 1888 at an estimated cost of Rs. 41,92,561. Its construction was begun in 1889 and completed in 1895, but the realignment of the main canal from Dadupur to Indri has not yet been carried out. The Western Jumna Canal has, up to date, cost some 177 lakhs of rupees and it irrigated about 725,000 acres in the year under review, returning a net profit of nearly 11 per cent.



NANUANA TRIFURCATION REGULATOR, LOWER CHENAB CANAL.

Sirhind Canal, 1870-1884

While the Upper Bari Doab Canal was still under construction, a scheme for the irrigation of the country on the left bank of the Sutlej was broached, but this did not materialize until 1870, when the estimate for the Sirhind Canal was sanctioned. Irrigation commenced in 1884, and in the year under review an area of over 900,000 acres was irrigated from it. The capital cost of the system exceeds 256 lakhs of rupees, upon which the returns vary from 6 to 11 per cent, the variations depending on the rainfall, to which this canal is very sensitive.

Early colonization. The Lower Chenab Canal, 1887-1900.

Hitherto canal construction had been confined to the more populous parts of the Punjab, but in the early eighties the drier districts and waste lands began to receive attention. The Lower Sohag and Para Canals, which take out from the right bank of the Sutlej opposite Fazilka, and the Sidhnai on the left bank of the Ravi above its junction with the Chenab, were constructed between 1883 and 1887 and, besides being immediately successful, they afforded valuable experience in colonization. The Sidhnai Canal, to which the supply is ensured by a needle dam across the river, irrigates some 350,000 acres annually and gives a net return of between 30 and 40 per cent. upon a capital outlay of rather more than 13 lakhs of rupees. The Lower Chenab Canal, for the irrigation of the lower portion of the tract lying between the Chenab and the Ravi rivers, was opened as an inundation canal in 1887, but from the outset it suffered from deposits of silt, and it was realized that without a weir across the river at its head, to ensure its supply, it would be a complete failure. The construction of the Khanki weir was sanctioned in 1889 and completed within two years, a notable achievement much to the credit of Mr. Maclean, the Executive Engineer, and the staff under him. As soon as the supply was assured by the weir, Colonel Jacob, R. E., pressed for the extension of the canal into the large areas of crown waste which were till then lying practically valueless. This extension was sanctioned in 1891 and the colonization of the waste lands then commenced. The Lower Chenab Canal is easily the most productive work in India. It irrigates about 2¼ million acres annually and in the year under review produced a net revenue of 128 lakhs of rupees on a capital outlay of 325 lakhs, a return of nearly 40 per cent. The accumulated surplus revenues of this canal, after paying interest charges, amount to no less than 1,388 lakhs of rupees.

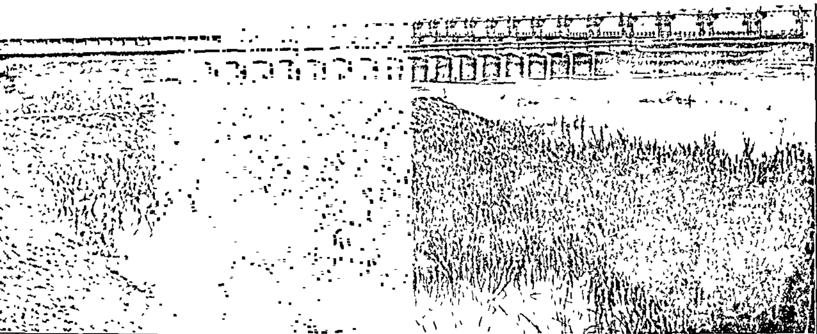
Lower Jhelum Canal, 1898-1902

The Lower Jhelum Canal project was sanctioned in 1888, but work on it was postponed for want of funds till the Lower Chenab Canal had made considerable progress and it was not until 1898 that the work was taken up in earnest. It was opened for irrigation in 1902, although construction was not quite completed,

In the case of both the Lower Chenab and Lower Jhelum Canals, construction and irrigation went on side by side, since, the tract being dry and inhospitable, the canals had themselves to bring water for the construction of the masonry works. The canal commands the lower portion of the tract between the Chenab and the Jhelum, and is another extremely lucrative work, irrigating about 800,000 acres annually, and returning over 20 per cent. on an outlay of 162 lakhs of rupees.

The Triple Canal Project, 1905-1915.

The Triple Canal Project was commenced in 1905; of its three component parts, the Upper Chenab Canal was opened in 1912, the Lower Bari Doab Canal in 1913, and the Upper Jhelum Canal in 1915. A reference to the map will show that the four rivers, Jhelum, Chenab, Ravi and Sutlej, flow convergingly in a south-westerly direction, the first named being the most northerly. The particular problem confronting the Punjab engineers was the irrigation of the tract between the Sutlej and the Ravi, and since the supply of the latter river was required in its entirety for the existing Upper Bari Doab and Sidhnai canals, a canal from the Sutlej naturally offered the easiest solution. A project for the irrigation of the Lower Bari Doab from the Sutlej was prepared, but, as the result of representations made by Colonel Jacob and Sir J. Wilson, the Irrigation Commission of 1901-02 advised the consideration, in preference to it, of a project to irrigate the doab by water brought from the river Jhelum across the rivers Chenab and Ravi. Two considerations led to the adoption of the latter scheme, *viz.*, firstly, that there were large supplies in the Jhelum, much larger than could possibly be used in the Jhelum-Chenab watershed, and that the irrigation of the Ravi-Sutlej tract was the only possible means [illegible] ...ondly, that there was [illegible] ...ater would eventually [illegible] ... on the left bank of the [illegible] ...d in consequence the Triple Canal project was prepared by Mr. (now Sir John) Benton, Chief Engineer, Irrigation Works, Punjab. Under this project water is carried by the Upper Jhelum Canal from Mangla on the river Jhelum to a point above Khanki, the headworks of the existing Lower Chenab Canal, on the Chenab. This renders it possible, without interference with existing irrigation, to draw off water from the Chenab at Merala, forty miles above Khanki, and to convey it by the Upper Chenab canal to the Ravi at Balloki, crossing the latter river by means of the Balloki level crossing. The water is thus delivered on to the Ravi-Sutlej tract for irrigation by the Lower Bari Doab Canal. The Upper Jhelum and Upper Chenab canal throw off branches as they traverse the tracts between the rivers, and so irrigate the remaining portions of the Jhelum-Chenab



SUKETAR LEVEL CROSSING, UPPER JHELUM CANAL.

and Chenab-Ravi watersheds. The total cost of the project, the construction estimate of which was closed at the end of 1916-17, has amounted to nearly 1,033 lakhs of rupees and it is anticipated that 1,900,000 acres will eventually be irrigated by the system. Although the most important link in the series, the Upper Jhelum Canal, was only opened in December 1915, nearly 1,200,000 acres were irrigated in the year under review. The construction of the Upper Jhelum Canal was beset with engineering difficulties, owing to the large number of hill torrents that it had to pass across in high embankments, the heavy excavation in its upper reaches, and the location of the head regulator at Mangla. The Upper Chenab Canal, with a bed width of 240 feet, a full supply depth of 12 feet and a capacity of 11,700 cubic feet per second is one of the largest perennial irrigating canals in the world.

Progress made in the Punjab in last half century.

The progress that has been made in the Punjab is demonstrated by the following figures which show the areas irrigated by Government irrigation works at the end of each interval of ten years since 1867-1868:

	Acres.
1867-68	1,025,166
1877-78	1,324,480
1887-88	2,341,103
1897-98	5,211,649
1907-08	6,039,944
1917-18	9,063,901

These progressive figures show the vast irrigated area added to the province in the last half century, but the Punjab Canals are responsible for a great deal more. The expansion of railways and the rapid growth of their earnings, the improvement in communications, the increase in the financial stability of the province, the large exports of surplus agricultural produce and the relief to congested districts by the colonization of crown waste are all developments in which the Punjab canals have had a leading share. Moreover, the canals are not only very profitable investments to Government but a source of increased profit to the cultivator. The average yield from an acre of wheat in the Upper Bari Doab tract, which is comparatively well favoured with rainfall, is estimated to have a gross value of about Rs 31 or Rs. 21, according to whether it is matured with the aid of canal water or not; the occupiers' rate levied for the use of the canal water is, however, only Rs. 3-12-6 per acre, so that the increased outturn is greatly in excess of the rate charged.

Colonization

Before the advent of the Lower Chenab, Lower Jhelum and Lower Bari Doab Canals, the tracts which they now serve were practically waste land The soil was good in most parts, but owing to the scanty rainfall and low water table, crops could be cultivated only in drainage depressions and the rest of the country was covered with scrub jungle. The inhabitants were few and depended for their existence on their camels and cattle, whilst they did a fairly brisk business in cattle-stealing. The absence of railways and other communications in the Jech and Rechna Doabs made the land practically valueless, and it could be bought for nominal sums of a few annas per acre by anyone who was willing to pay the land revenue : the crown waste brought in little or no revenue to Government In the Lower Bari Doab the existence of railways gave some slight value to the land and crown waste was valued at Rs. 1-9-0 per acre.

Canal water has transformed these unfruitful areas into highly cultivated tracts containing well built villages and large towns and markets The enormous output of grain has led to a rapid extension of the railway system, and roads have been provided for in the system of land demarcation adopted as a preliminary to successful colonization and distribution of water The original colonists drawn from the congested districts of the Punjab have supplied the necessary cultivators for the greater part of the crown waste land, whilst even the original nomads of the tract have taken to agriculture and honest livelihood.

In the first experiment in colonization (the Rechna Doab), the crown waste was allotted in three ways. Peasant grants consisted of a half to two squares each, *i e*, 14 to 56 acres each and the recipient, after fulfilling certain conditions, received occupancy rights after five years. Yeoman grantees who received four to five squares had to pay "nazarana" at Rs. 6 per acre on entry. Capitalists who took up larger areas had to pay as many rupees per acre as there were squares in their grants with a minimum of Rs. 10. At a later date the peasant grantees were allowed to acquire proprietary rights on the moderate payment of Rs. 12-8-0 per acre, and other grantees at a rate *the average of which was about Rs. 20-10-0 per acre* *Some* of the land, but not much, was allotted on service conditions for camel and mule breeding.

In the Jech Doab, crown waste was usually allotted on horse breeding conditions to provide army remounts. In the Lower Bari Doab Colony, proprietary rights are obtained on a payment of Rs. 70 to Rs 100 per acre, and a large area is reserved for grants for war services.

TYPICAL VIEWS OF A COLONY TRACT

BEFORE IRRIGATION.



In all the colonies, small areas have been sold by public auction from time to time to test values and for other reasons. The average price has varied from about Rs. 200 to Rs. 300 per acre, and is a good indication of the advance in the value of the land which, before the advent of the canal systems, was almost worthless. In special cases, such as in large towns or near markets, the price paid has been as much as one rupee a square foot.

Works under consideration: The Sutlej Valley Canals.

Five important schemes are at present under consideration. The Sutlej Valley Canals Project is the direct outcome of the forethought of the originators of the Triple Canal Scheme, the Sutlej-Beas water, freed from the claims of the Ravi-Sutlej tract, being utilized to improve the inundation canals on both banks of the river and to protect a considerable area of land, which is at present unirrigated. The land on the right bank is entirely in British territory, while that on the left lies mainly in the States of Bahawalpur and Bikanir. The project provides for two weirs on the Sutlej and four canals, two on each bank, the estimated cost is Rs. 990 lakhs of rupees and over 1½ million acres of new irrigation should be effected annually. The scheme is at present under the consideration of the Government of India.

The Bhakra Dam scheme.

The Bhakra dam scheme is intended, in addition to providing irrigation to parts of Bikanir State, to fulfil the object which was aimed at by the Sarda-Ganges Jumna Feeder Project, namely to extend irrigation into the arid and frequently famine stricken tracts of Rohtak and Hissar districts. The proposal to store the excess summer supply of the Jumna by means of a dam at Koch having been given up on account of the unsuitability of the site, a project is now being investigated involving a dam on the Sutlej at Bhakra, about 40 miles above Rupar, the head works of the Sirhind Canal, where water is to be stored to a depth of 360 feet above river bed. About 110,000 million cubic feet of water will thus be impounded during the monsoon, without prejudice either to the existing irrigation on the Sirhind Canal or to that projected in the Sutlej Valley scheme. The project will include a barrage on the Sutlej below Phillour and a considerable remodelling of some of the channels of the Sirhind Canal, which will be linked up with the Sirsa Branch of the Western Jumna canal. The cost of the project, which is a difficult and complicated one, is estimated at approximately 10 crores of rupees, and about 1·4 million acres of new irrigation will be secured; the Bhakra dam, if built as designed, will be higher than any dam now in existence.

The Haveli Project.

The Haveli project has been prepared to counteract the large variations in the supply of the Ravi for the Sidhnai canal and to provide better supplies for the Multan series of inundation

canals, the insecurity of which has been increased by the opening of the Triple project. The essential feature is a barrage across the Chenab below its confluence with the Jhelum, with canals on either bank. The project has been returned by the Government of India for reconsideration, but beyond collecting more data as to the river discharges likely to prevail when the Triple Canals are in full working order, nothing has been done in the way of revising the project, pending a settlement of certain outstanding matters at issue with Bahawalpur State.

The Thal Project.

A project is under preparation for the irrigation of the Sind Sagar Doab, which lies between the Indus and Jhelum rivers. The project will secure more than $1\frac{3}{4}$ million acres of irrigation annually out of a gross area of 5 million acres, a large portion of which at present affords only precarious grazing. Nearly half of this gross area will be available for colonization after local requirements have been met. A return of about 8 per cent. is anticipated on the estimated capital expenditure of about $8\frac{1}{2}$ crores of rupees.

Woolar Lake Barrage.

The Woolar Lake Barrage has for its object the storing of water in the Woolar Lake on the Jhelum in Kashmir during the monsoon period for use in the Punjab Canals in the winter. The barrage is estimated to cost 15 lakhs of rupees and negotiations for its construction are being carried on with the Kashmir Durbar.

Progress anticipated.

The statement below shows the extensions of irrigated area which are anticipated when the principal works under consideration are in full working order.—

Stage of work.	Name of work.	Area in acres.
Under consideration.	Sutlej Valley Canals ..	1,666,000
	Bhakra Dam	1,400,000
	Haveli Project	200,000
	Sind Sagar Canal	1,750,000
	Woolar Lake Barrage ..	..
	Total	5,016,000

The economical use of water.

A considerable amount of experimental work, with a view to effecting economies in the amount of water utilized, has been carried out in the Punjab, but with no very definite results as yet. One direction in which such investigations have been made is that of the lining or water-proofing of canals, whereby the large percolation losses which now take place might be obviated. The process of lining channels on a large scale would, however, be expensive and one difficult to adopt on running canals. A

second line of investigation has lain in experiments with modules, which are devices for ensuring that the cultivator receives a constant supply of water independent of the level of the supply in the distributing channel and the amount of clearance the cultivator may do to his watercourse. To this end experiments have been undertaken with the Gibb Module and the Stoddard-Harvey Module, whilst the Kennedy Gauge Outlet is largely used on the colony canals by reason of the discharge through it being independent of the level of the water in the watercourse, though not of the level in the distributing channel The third enquiry relates to the practicability of selling canal water by volumetric measurement. Experiments made departmentally and by the Agricultural Department tend to show that some crops, especially wheat, can be matured, and even benefited, by the use of a much less quantity of water than is now generally used by the cultivator. It is, therefore, considered that a change from payment for water per acre irrigated at rates varying with different crops, to payment at a rate per unit of volume of water supplied, might result both in economy in the use of water and in an extended area under irrigation. A contract has been entered into with a landowner in the Lower Bari Doab for the supply of water to him for irrigation at bulk rates, the water being measured and delivered to him at the head of a minor distributary.

Water-logging.

The question of the conservation of water is related to that of water-logging of the soil. The steady rise of the spring level in the colonies together with the appearance of water-logging in extensive areas has led to an examination of the problem, to the excavation of surface drains on the upper reaches of the Lower Chenab Canal and to the formation of a special drainage division on the Upper Bari Doab, from which important improvements in the surface drainage of that tract may be looked for. An interesting experiment is being carried out on this canal at Amritsar, where a hydro-electric installation operates pumps which pump up the subsoil water in a tract which has become partially water-logged and, by returning it to the surface of the land, to replace canal irrigation. Of the fifteen tube wells sunk for the purpose some have unfortunately proved defective, with the result that it has not yet been possible to cut off the canal supply entirely. The inefficient wells are being resunk, and when this is done and the installation has been steadily at work, it will be possible to say definitely how far the anticipated results have been obtained.

Water-power.

There is a very large quantity of water-power available on the Punjab Canals Some of this power is used for industrial purposes, chiefly for flour and woollen mills, but the fact that the flow is unavoidably intermittent is a stumbling block to its adoption as a motive power in most industries.

CHAPTER VIII.

BURMA.

General conditions in Burma.

The configuration of Burma does not admit of very large irrigation schemes. The climate and soil favour the cultivation of rice, which is the main staple of the country. This crop requires an excessive amount of water, the canals are therefore considerably larger in proportion to the area irrigated than is usually the case in India and are more costly, especially as all rates in Burma are high.

Productive irrigation works. The Shwebo Canal.

The largest area commanded by any one work is that commanded by the Shwebo Canal This canal, which has its head on the Mu river, was opened in 1906 It was constructed at a cost of about 60 lakhs of rupees and irrigates about 160,000 acres, returning 8½ per cent on its capital outlay. The area commanded is about 72 miles in length, with a width varying up to a maximum of 16 miles. This tract, which is now a practically unbroken succession of rice fields, was before the construction of the canal mostly covered with scrub jungle with scattered areas under miscellaneous dry crops and in favoured localities small areas of rice lands dependent on local drainages In the north-east corner of the area there was formerly an old Burmese one-bank canal, which intercepted the local drainage and stored a certain amount of water in two or three depressions. The resulting irrigation was naturally precarious and dependent on good rainfall. In general, rice crops were successfully matured in one year out of five or six; in other years the crop was deficient or failed. The whole area covered by the Shwebo Canal is now secured and the average outturn per acre has very largely improved, the increase varying from 9 baskets of 46 lbs. per acre from 3rd class lands to 35 and 40 baskets from 1st class areas.

In the years before the construction of the Shwebo Canal, a large proportion of the inhabitants of the Shwebo district annually migrated to Lower Burma for the cold season to help in reaping the enormous area under rice. By this means and in various other ways they supplemented the scanty living made from their fields in Upper Burma, and in the course of time a good many families abandoned their holdings in Upper Burma and settled in Lower Burma. The construction of the Shwebo Canal has stopped this annual migration from the canal area, and all who had abandoned their fields have since returned and settled down

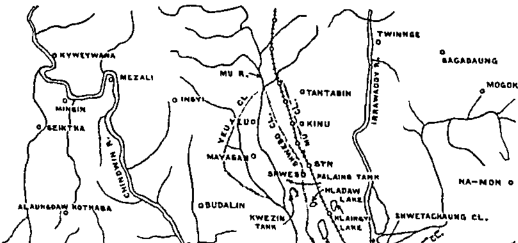
UPPER BURMA
SKETCH MAP OF CANALS

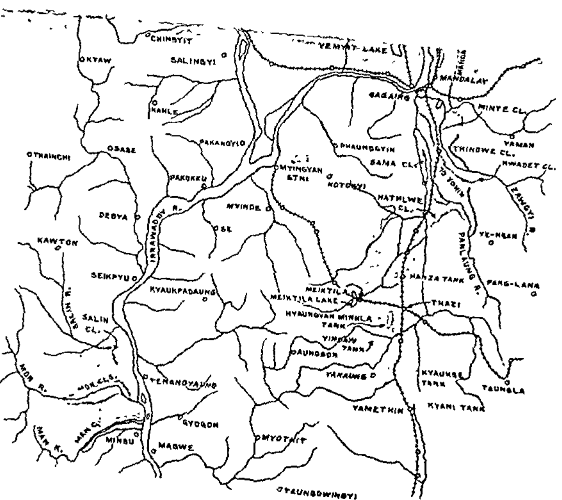
Scale — 1 Inch = 32 miles.



REFERENCES

Rivers ....
Existing canals ....
Area commanded .....
Railways ....




CHINSYIT
YEMYIT LAKE
OKTAW
SALINGYI
MANDALAY
SAGAING
KAHLE
MINYE CL.
YAMAN
PAKANGYI
OSASE
OTHAINCHI
PHAUNGGYIN
THINDWE CL.
SAMA CL.
NWADET CL.
MYINGYAN
ETNI
NGTOGYI
TO YOKIN
PAKOKKU
ZAWGYI R.
HATHLWE CL.
MYINDE
DEBYA
IRRAWADDY R.
OSE
YE-NGAN
KAWTON
PANLAUNG R.
HANZA TANK
SEIKPYU
PANG-LANA
MEIKTILA
KYAUKPADAUNG
MEIKTILA LAKE
THAZI
SALIN R.
SALIN CL.
NYAUNGYAN MINHLA TANK
YINDAW TANK
DAUNGGON
MON R.
MON CLS.
YENANGYAUNG
YAMAUNG
KYAUKSE TANK
TAUNGLA
YAMETHIN
KYANI TANK
GYOGON
MAN CL.
MAN R.
MINBU
MAGWE
MYOTHIT
OTAUNGDWINGYI

contentedly. Other families from the adjoining dry districts have come in and occupied the new lands opened out, and a marked increase in prosperity is evidenced in the many new villages established, in the improvement in the type of village houses and in the construction and improvement of monasteries and travellers' rest houses erected by the people. There has been a general increase of trade throughout the district, thriving shops have been opened up in wayside places and everywhere there has been a marked improvement in the standard of living New roads have been opened and a service of motor cars has been inaugurated on the only two metalled roads in the district.

The general increase in population in the canal area between the years 1909-10 and 1917-18 may be taken as about 4,000 households or roughly about 16,000 people ; the figures for earlier years are not available but these would indicate a still larger increase, as the great influx of people occurred on the opening of the canal in 1906 to 1908. The rise in land value all round has also been considerable. Excluding waste lands, which have since been brought under the plough, lands previously sown with winter rice, now the most valuable crop, sold at from Rs 17 to Rs. 21 per acre, while they are now valued at rates varying from Rs. 25 per acre for fourth class lands to an average of Rs. 55 per acre for first class soils.

The Mandalay Canal, which takes off the Madaya river, 32 miles from Mandalay, was opened for irrigation in 1902, and 61,000 acres were secured in the year under review. The capital cost of 57 lakhs of rupees has been considerably enhanced by the outlay consequent upon a serious accident to the headworks which occurred in 1913, when an unprecedented flood, carrying huge masses of uprooted trees and logs, destroyed the under-sluices and damaged the head regulator. The four original under-sluices, each 32 feet ... been replaced by ... , and with a clear ... gate in existence. The Mand Canal.

In the Mandalay Canal area the general variety of rice planted, brought from Lower Burma and called "ngasein," has increased both in size and quality in the canal tract and is now locally known as "ngasein-gyi" or the large "ngasein." The mean sale value of non-state land has increased from Rs. 37 per acre to Rs. 69 per acre, and in the case of state land from Rs. 8 to Rs. 35 per acre.

The Mon Canal, in the Minbu district, which was opened in 1911, has involved up to date an outlay of 57 lakhs of rupees, and it is anticipated that, when fully developed, 68,000 acres will be irrigated from it. In the Mon Canal tract, since the canal was The Mon C

opened in 1910-11, the population has increased from 12,329 households to 16,438, which corresponds approximately to about 17,000 souls The value of land in the Minbu district is higher than that elsewhere. Before the Mon Canal was opened in 1910 the sale value of non-state land varied from Rs. 25 to Rs. 50 per acre. According to sale registration in the local courts the value now ranges between Rs 80 and Rs 150 per acre. The mean increase may be taken as varying from Rs 35 to Rs. 130.

The quality of paddy grown on the Mon area before the construction of the canal was inferior to that now grown, and the former total outturn of rice and miscellaneous dry crops in a good year has been estimated at only Rs 8,27,000. The value of the crop grown last season, as estimated by the Deputy Commissioner, was Rs. 28,66,000. Owing to lack of export facilities due to the war the sale prices of paddy were below those ordinarily obtaining in years prior to the war.

Minor works.

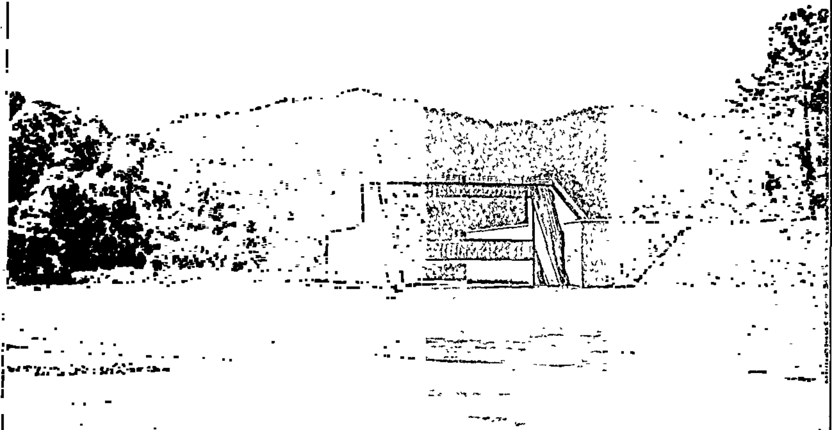
On the annexation of Upper Burma in 1885, the numerous indigenous irrigation canals and reservoirs were found to be in a very bad state of repair, owing to the unsettled state of the country, and attention was immediately directed to their improvement; in almost all cases the head works have been remodelled and the canals regraded. Further improvement is contemplated by the linking up of certain of the systems and by the checking of the present indigenous, but wasteful, methods of distribution. Owing to the care expended on these works since the annexation, the area irrigated by them has extended from 200,000 acres to double that amount.

Embankments in the Irrawaddy delta.

The rainfall in Lower Burma is sufficient for the cultivation of rice, the staple crop of the country, without artificial irrigation, but the periodical flooding, due to spill water from the Irrawady, of large tracts of country in the delta suitable for the crop, necessitated measures for their protection. The question began to receive attention on the termination of the second Burmese war, and in 1861 certain small protective embankments, constructed by villagers, were taken over. By the end of 1888 the length of these embankments had been increased to 300 miles, and a further length of 50 miles was added in the following ten years, since which time no more work of this nature was undertaken until the year 1916-17, when work was commenced on the Yandoon Island embankment, which is referred to in a later paragraph The total area protected by such embankments, excluding small embankments on the Sittang river, now amounts to 800,000 acres.

Navigation works.

There are only two important navigation works in Burma, the Pegu-Sittang Canal and the Twante Canal. The former, which



HEAD SLUICE, MANDALAY CANAL

connects the Pegu and Sittang rivers, was completed in 1878; it is 38 miles long and consists partly of original creeks and partly of new cuts joining up the existing channels. The cuts have been given a bed width of 50 feet, and locks have been provided at both ends of the canal, a branch, 6 miles long, connects the main line with the town of Pegu. The canal represents a total outlay of 80 lakhs of rupees, and in the year under review 1½ lakhs were received from tolls Work on the improved Twante Canal was commenced in 1913 and completed in March 1917. The scheme provides for the widening and deepening of the previously existing waterway, comprising the Twante Canal and the Kanaungto and Twante Creeks, and the excavation of a chord cut to shorten the distance from the Twante Creek to the Rangoon river. The canal as constructed connects the western delta of the Irrawaddy with Rangoon; the channel has a bed width of 300 feet and a depth of 6 feet (except in the chord cut where the bed width is reduced to 180 feet), and is open to the free flow of the tides. Excluding arrears of interest the capital cost of the canal amounts to 53 lakhs of rupees and it is expected to return 7½ per cent on this outlay. The net revenue realized from tolls during 1917-18 amounted to 3 lakhs of rupees, which compares favourably with the project forecast for the year.

Works under construction: The Ye-U Canal.

The only major irrigation work under construction is the Ye-U canal. This canal takes off from the Mu river at the same point as the Shwebo canal but on the opposite bank, and is designed to irrigate about 110,000 acres. There has been some delay in completing this work, partly owing to the troublesome nature of the drainage system and partly owing to the depletion of the irrigation staff during the war. The sites of all cross drainages have

the cost of construction. It is hoped that construction will be sufficiently advanced to enable the greater part of the canal to be opened for irrigation during the ensuing cultivating season. Serious trouble has also been met with in freeing the headworks of the Ye-U canal from river sand. Training works have greatly improved conditions, but it will probably take some years before complete success is attained.

Yandoon Island embankment.

A project for the embankment of the Yandoon Island, a triangular area in the eastern delta of the Irrawaddy, was sanctioned during the year 1916-17 and fair progress was made in the year under review. In the upper reach of the island the depth of flood water held up by the embankment is considerable, especially where of late years the Irrawaddy has made increasing efforts to break

across the island. The soil met with in the upper sections of this embankment is poor and the bank is liable to become saturated with water and slip. Several breaches have already occurred and, as it is absolutely essential to safeguard cultivators taking up land within the protected area, it is intended to strengthen and raise the bank sections at considerable cost. The area protected by the embankments is being reserved for members of the Village Co-operative Credit Societies. These Societies have already made great progress in Burma and it is desirable to make every effort to encourage them. The area protected by the Yandoon embankment is roughly estimated at 93,000 acres, and the project may be expected to pay from 23 to 25 per cent.

Projects under consideration.

The largest project at present under consideration in Burma is that for embanking the left bank of the Irrawaddy river in the upper delta for 120 miles, from Tullokmaw to Yandoon. A preliminary estimate, amounting to 62 lakhs of rupees, has been prepared, and it is anticipated that over half a million acres of land will be protected, and that the scheme will return 20 per cent. upon the capital cost. The war has, however, greatly depleted the irrigation staff in Burma and this project is being kept in abeyance for the present until sufficient establishment is available to carry out the large survey necessary. The final estimate for the Kinda project is now ready and work will be taken up when funds permit. Detailed [illegible]

Summary of progress of irrigation.

During the past 25 years the area irrigated by State works and protected by State constructed embankments has more than doubled, as is shown by the table below :—

Year.	Major works.	Minor Works.	Embankment.	Total.
	Acres.	Acres.	Acres.	Acres.
1891-92 ..	*Nil.*	196,331	416,369	612,700
1901-02 ..	*Nil.*	250,130	592,138	842,268
1909-10 ..	205,076	313,852	645,671	1,164,599
1917-18 ..	263,656	373,603	778,268	1,415,527

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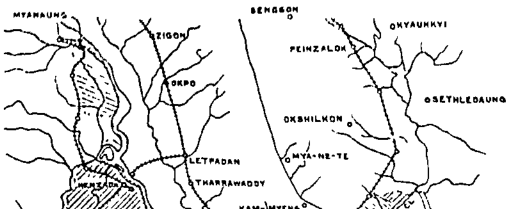


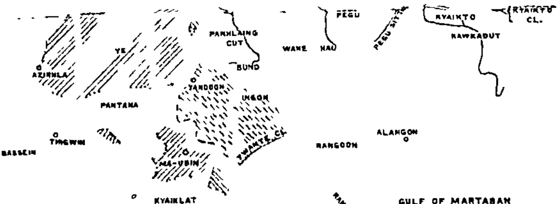
AZIRNLA
BUND
YANDOON
INGON
PANTANA
TINGWIN
BASSEIN
TWANTE CL
MA-UBIN
ALANGON
RANGOON
KYAIKLAT
GULF OF MARTABAN
RANGOON R.
PYAPON
THANDEIK R.
DONYAN R.
PYAPON R.
KYONKADUR
YWE R.
PYAMALAW R.
PAINSALU R.
IRRAWADDY R.
DALA R.
MOUTHS OF THE IRRAWADDY
REFERENCES
Rivers
Navigation canals
Embankments
Area protected
Proposed embankment
Area proposed to be protected
Railways

LOWER BURMA

SKETCH MAP OF NAVIGATION CANALS & EMBANKMENTS.

Scale — 1 inch = 32 miles





PEGU
KYAIKTO
KYAIKYO CL.
KAWKADUT
PEGU SITTANG
PANHLAING CUT
WANE
NAU
BUND
YE
AZIRNLA
YANDOON
INGON
PANTANA
TINGWIN
BASSEIN
MA-UBIN
TWANTE CL.
RANGOON
ALANGON
KYAIKLAT
GULF OF MARTABAN
RANGOON R.
BYA GYI
PYAPON
THANDEIK R.
DONYAN R.
PYAPON R.
KYONKADUR
YWE R.
PYAMALAW R.
PAINSALU R.
IRRAWADDY R.
DALA R.
MOUTHS OF THE IRRAWADDY
REFERENCES
Rivers
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Area proposed to be protected
Railways

The following table shows the extensions of irrigated and protected area anticipated when the principal works now under construction and under consideration are completed :— Progress anticipated.

		Acres.
Under construction.	Ye-U Canal	110,000
	Yandoon Island embankment ..	93,000
Under consideration.	Remodelling Man Canal	7,000
	Remodelling Salin Canal	25,000
	Remodelling Kinda Canal	14,000
	Remodelling Mu Canal	40,000
	Extension Shwebo Canal	12,000
	Double banking Irrawaddy	500,000
	Magwe system of Canals	70,000
	Yamethin Canal	16,000
	Total	887,000

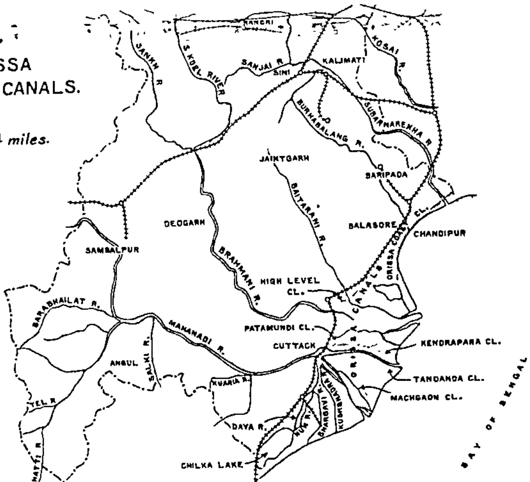
CHAPTER IX.

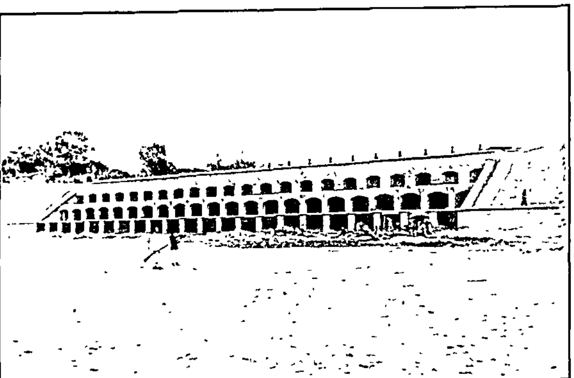
BIHAR AND ORISSA.

The Orissa Canals. THERE are three irrigation works of considerable magnitudc Bihar and Orissa, namely, the Orissa and the Son systems of car and the Tribeni Canal. The two first mentioned are parts of great, but ill-fated, project of the East India Irrigation and Ca Company already mentioned The Orissa Canals form a somew complicated system, consisting of a series of navigation can with irrigation branches, radiating from the Mahanadi at Cutt down the islands of the delta of that river, and a high level navi tion canal, running in a north-easterly direction almost to t Salindi river at Bhadrak. The latter was originally intended provide through inland communication between Cuttack a Calcutta, but was never completed; it now serves the purposes bo of navigation and irrigation, but neither very successfully, as t supply is poor and grading designed for navigation does not su irrigation canals The capital outlay on the system up to da amounts to over 270 lakhs of rupees, it was opened for irrigation 1866 and by October 1867 the Company was prepared to supp water for over 150,000 acres, but up to 1876-77 it did not irriga more than 30,000 acres out of the 570,000 acres commanded, wh it was not till 1902 that its revenue exceeded its working expense It now irrigates 280,000 acres annually, bringing in, with the hel of navigation and other receipts, a gross revenue of over 5½ lakh of rupees. These canals not only provide the country with wate for irrigation and open up communications, but serve also as floo embankments. The added security and prosperity in the delt is largely due to them, and though it has not been found possibl to show any direct profit to Government from their constructio they are a very distinct asset to the province.

The Son Canals. The Son Canals were originally commenced, also by the Eas India Irrigation and Canal Company, as part of an ambitious projec to provide navigable canals running from Dehri-on-Son to Benare and Monghyr with branches, also navigable, down the main water sheds. The supply was, however, found to be quite inadequat for so extensive a scheme, and it was cut down to its present dimen sions; it now consists of three main canals from Dehri-on-Son t Buxur, Arrah and Digha (near Patna), with numerous branches fo irrigation only. 269 lakhs of rupees have been expended upo them up to date and the annual gross revenue from all source


N
TRIBENI CL.
TEUR CANAL
DHAKA CANAL
BETTIAH
GORAKHPUR
MOTIHARI
SITAMARHI
GANDAK RIVER
BAGHMATI R.
SIKRAHANA R.
DARBHANGA
PRATAPGANJ
KOSI R.
PANAR R.
KANKAI R.
MAHANANDI R.
DANK R.
MUZAFFARPUR
GOGRA R.
CHAPRA
KATIHAR
BANKIPUR
PATNA
GANGES R.
SON CLS.
DUMRAON CL.
ARRAH CL.
BUXAR CL.
MUGHAL SARAI
PATNA CL.
PUNPUN R.
PHALGU R.
BIHAR
BANKA
DEHRI
GAYA
AURANGABAD
SON R.
MADHUPUR
BARAKAR R.
CHATRA
KOEL R.
AMANAT R.
HAZARIBAGH
DAMODAR R.
RANIGANJ


BIHAR & ORISSA
SKETCH MAP OF CANALS.
Scale—1 inch = 64 miles.
REFERENCES.
Rivers
Existing canals
Area commanded
Railways
Provincial boundary
SANKH R.
S. KOEL RIVER
SANJAI R.
SINI
KALIMATI
KOSAI R.
SUBARNAREKHA R.
BURHABALANG R.
JAINTGARH
BARIPADA
BAITARANI R.
BALASORE
CHANDIPUR
ORISSA COAST CL.
CANALS
DEOGARH
BRAHMANI R.
HIGH LEVEL CL.
SAMBALPUR
BARABHAILAT R.
MAHANADI R.
PATAMUNDI CL.
CUTTACK
KENDRAPARA CL.
TANDANDA CL.
MACHGAON CL.
ANGUL
SALKI R.
KUARIA R.
TEL R.
DAYA R.
NUN R.
BHARGAVI R.
KUSHBHADRA
CHILKA LAKE
BAY OF BENGAL



HEAD SLUICE, TRIBENI CANAL.

amounts to about 19 lakhs and is gradually increasing After deducting working expenses the return on capital is about 4 per cent, and the accumulated arrears of interest are now being slowly but steadily worked off. Prior to the opening of the canals the tract traversed by them was chiefly a *rabi* growing area; a considerable rice crop is now grown and some 470,000 acres of rice and from 60,000 to 215,000 acres of *rabi* are irrigated annually.

The Tribeni Cana[l]

The Tribeni Canal was commenced as a famine relief work in 1897 for the purpose of bringing water from the Gandak to the rice growing area north of the Sikrana river in Champaran To reach this area the drainage of the outer range of hills had to be crossed for a distance of 60 miles, and the difficulties involved were considerably under-estimated. The cost of the project was originally anticipated as 38 lakhs of rupees; the last revised estimate amounted to double this sum The tract traversed lies in the Tarai and, owing to the unhealthy nature of the country, progress was slow and irrigation did not commence till 1911, while one distributary is still incomplete The area irrigated annually is now usually between 50,000 and 60,000 acres, and has in one year risen to 76,000; when fully developed the canal is likely to irrigate about 90,000 acres out of a commanded area of 271,000, but an extension is possible which may improve the financial prospects of the work to some extent, though it is never likely to pay more than two per cent. The tract is liable to very heavy bursts of rainfall, though usually local in extent; in 1915 a most exceptional extended burst of heavy rain occurred and did considerable damage, breaching the canal in no less than 67 places The masonry works, with two

Scope for further extensions.

The area irrigated from Government canals has more than doubled in the last thirty years, the figures at intervals of ten years being as follows :—

	Acres.
1867-68	9,836
1877-78	342,285
1887-88	424,886
1897-98	629,047
1907-08	964,074
1917-18	861,039

The drop in the last period is due to fluctuation in the rabi area on the Son Canal; in 1917-18 only 68,101 acres were irrigated owing to good rain for sowing, while in 1907-08 the area was 205,466 acres, a figure only exceeded in the famine year 1896-97. Except for

seasonal fluctuations of this sort there is not much extension of irrigation to look forward to on existing canals, beyond the area noted above against the Tribeni Canal. There are however certain possibilities, the investigation of which has been checked by the depletion of establishment owing to the war. The preliminary reconnaissances for reservoirs for the Son Canal have shown that the Koel and its tributaries provide one or more fair storage sites, and that it may be feasible to supplement the October supply by this means sufficiently to allow of some extension of the canal system, but no details of cost are yet available. Similarly it can be said that the area irrigated now by range III of the High Level Canal in Orissa could be better served from a weir higher up the river and that as much area again could be obtained therefrom on land now uncommanded, but in this case also figures of cost are as yet unavailable Further investigation of the project prepared for the irrigation of part of south Monghyr from the Kiul river has proved that the original proposals involved too high an expenditure; a rather less ambitious scheme may perhaps be possible at a reasonable cost, and this question has now to be investigated There appears to be some possibility of irrigation from storage reservoirs in the Government estates in Singhbhum and the matter is being investigated by the local staff.

Though there is not at present any great prospect of extending the irrigated area, the crop experiments point to the possibility of further income from enhanced water rates, though any enhancement has to be very gradual, especially in Orissa. In most parts of the [illegible]
from [illegible]
men [illegible]
On the Tribeni Canal, where the rate is as yet only Rs. 2, the profit from [illegible]
Rs. [illegible]
was [illegible]
less. [illegible]
the regular long lease system has been established it will probably be possible to enhance the rates fairly soon after its introduction,

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being investigated by the local staff.

Though there is not at present any great prospect of extending the irrigated area, the crop experiments point to the possibility of further income from enhanced water rates, though any enhancement has to be very gradual, especially in Orissa. In most parts of the province irrigation brings the rice grower an extra gross profit of from Rs. 10 to Rs. 11 per acre according to departmental experiments, while the rate for water varies from Rs 2 to Rs. 3-8-0 only. On the Tribeni Canal, where the rate is as yet only Rs. 2, the profit from

Rs.

was

less.

the regular long lease system has been established it will probably be possible to enhance the rates fairly soon after its introduction.



KATNI
JUBBULPUR
NARBADA R
MANDLA
WAINGANGA CANAL
BALAGHAT
BILASPUR
MAHANADI
RAIPUR
DRUG
MAHANADI CANAL
KARKARA
TANDULA CANAL
MARAMSILLI RESERVOIR
WAINGANGA R
TRI R.



HEAD WORKS, WAINGANGA CANAL.

CHAPTER X.

CENTRAL PROVINCES.

The introduction of Government irrigation works into the Central Provinces is of very recent date. During the years from 1871 to 1896 there was never a failure of the monsoon, on the contrary, a long wet cycle, within that period, caused serious injury to the crops in many parts of the province. It is not surprising, therefore, that the succeeding dry cycle, from 1897-1907 caused much bewilderment and found the cultivators unprepared; indeed in 1901-03, when the Irrigation Commission sat, they found that, in a normal year, only 7½ per cent. of the area under crops was irrigated from private tanks, wells or by means of field embankments, and that in a dry year this percentage fell to 1½. Consequently it happened that during the famine of 1899-1900 from 14 to 22 per cent of the population of the province was in receipt of relief, 168 lakhs of rupees being spent in gratuitous relief and 269 lakhs on famine works The necessity for State-controlled irrigation works for the protection of the province was hence apparent, and a considerable amount of work has since been undertaken to meet this need.

Necessity for Government irrigation works.

Three productive works are now in course of construction and, although none of them are yet complete, they have all been opened for irrigation The largest is the Mahanadi Canal, which has its off-take on the Mahanadi river fifty-two miles south of Raipur, the supply being supplemented by means of a storage reservoir of 8,230 million cubic feet capacity upon one of the tributaries of the river at Maramsilli The canal, which is estimated to cost 116 lakhs of rupees, is designed to irrigate 400,000 acres, and the rate at which this irrigation is developing is most hopeful; in the year under review 68,000 acres took water, although it was only the third year [illegible] en. [illegible] ne, [illegible] res per annum and is estimated to cost 48 lakhs of rupees. The canal is fortunately situated, as not only is there a catchment area of 2,600 square miles above the site of the head, but a reservoir of 570 million cubic feet capacity has been provided on the Sarathi nala to stabilize the supply. It was opened for irrigation in 1916, and 1,172 acres were irrigated in the year under review. The third productive work is the Asola Mendha tank in the Chanda district, a comparatively small work costing 18 lakhs and designed to irrigate

Productive works.

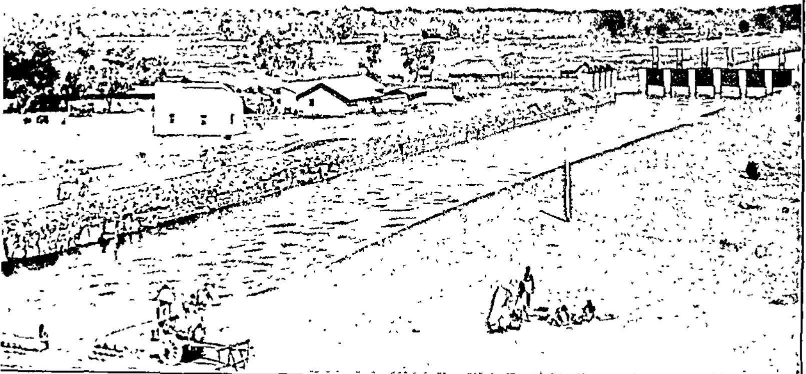
60,000 acres. The last mentioned tank is situated in a jungle area, where there is a good deal of forest to be cleared and where the population is limited. As might be expected in such circumstances development is slow but is nevertheless surely taking place, and gradually the forest is disappearing to make way for sugar cane and rice.

Protective and minor works.

Still greater progress has been made in the construction of protective works, and new systems have come into operation in almost every year since 1904. The Khola tank was the first to be opened, in 1904-05, and by 1916-17, 21 such projects were actually doing irrigation, of which 15 had been completed at an aggregate cost of 67 lakhs of rupees. Of these the Ramtek tank in the Nagpur district, which was completed in 1913-14, is by far the largest; it has involved a capital outlay of 29 lakhs of rupees, provides storage for over 4,000 million cubic feet of water, and is designed to irrigate 48,000 acres It is struggling under two difficulties at present; owing probably to the configuration of the hill ranges, the catchment receives less rainfall than the surrounding country, and hence the reservoir does not fill well, while the soil, which consists of black cotton soil, underlain by a water-tight subsoil, does not lend itself readily to irrigation. The latter difficulty is, however, being gradually overcome, and it will probably be possible to enlarge the catchment, should the development of irrigation warrant such a course. In addition to these works, nine further schemes, estimated to cost 153 lakhs of rupees, are under construction These include the Tandula Canal, a project of considerable magnitude, to cost a crore of rupees, which will irrigate a tract west of, and adjacent to, that commanded by the Mahanadi Canal The storage reservoir consists of two large lakes, formed by massive earthen embankments connected by means of a cutting, which will impound 9,000 million cubic feet of water, and it is anticipated that nearly 200,000 acres will be irrigated. The system will probably be completed in 1920. Seventeen minor irrigation works, estimated to cost 25 lakhs of rupees, are also in course of construction in the Central Provinces.

Projects under consideration.

The only large project under investigation at the end of the year under review was the Kharung tank scheme, of which the survey had just been completed. It is proposed to irrigate about 80,000 acres from this tank and thus to place the Bilaspur district, which at present possesses only four small tanks, in a better position to meet years of scarcity. A scheme for a right and left bank canal, with discharges aggregating over 3,000 cusecs, from the Hasdeo river, one of the finest rivers in the province, is also under investigation. It will, if constructed, be the largest scheme yet attempted in the Central Provinces and, the river having a flood discharge of some 540,000 cusecs, there is ample scope for the expansion of sugar cane, cotton, orchards and other choice crops, while rice will also be



TANDULA CANAL.

irrigated, a total area of 360,000 acres of irrigation being anticipated. A geologist has recently examined the site for the masonry dam at the off-take of the two canals, and borings to show the detailed character of the rock are in progress. The scheme has already been worked out in sufficient detail to show that it is feasible, and the preliminary project is now being modified and re-cast. The surveys of several smaller schemes were also in progress during the year under review.

Progress anticipated.

The table below shows the estimated areas to be irrigated by the principal projects which have been completed, are under construction, or under consideration in the Central Provinces

Stage of work	Name of work.	Area in acres to be irrigated by complete project
		Acres.
Recently completed	(1) Ramtek Reservoir ..	48,000
	(2) Khairbanda ..	17,000
	(3) Chandpur .	16,000
	(4) Asola Mendha ..	60,000
Under construction .. .	(1) Chorkhamara .. .	20,228
	(2) Bodalkasa .. .	18,376
	(3) Ghorajheri ..	15,000
	(4) Naleshwar .	12,0 00
	(5) Tandula canal .	263,112
	(6) Wainganga canal	85,000
	(7) Mahanadi canal . .	400 000
	(8) Bahori banda .. .	10,000
Estimates sanctioned	*Nil.*	*Nil.*
Under consideration	(1) Hasdeo river ..	360,000
	(2) Kharang river	75,000
	(3) Khori river .. .	73,000
	(4) Son canal .. .	61,000
	(5) Ghul ghul . .	28,800

CHAPTER XI.

NORTH-WEST FRONTIER PROVINCE.

The Lower Swat Canal.

State irrigation commenced in this province with the opening of the Lower Swat Canal, which has its head regulator on the left bank of the River Swat close to the Border and about two miles above the Abazai Fort. The leading idea in its construction was the pacification and settlement of the Border, and it was commenced at the end of 1876 as a famine protective work, as it was not believed that it would prove financially productive. It was completed in 1885, the work of construction having been delayed by the Afghan War, but has since that time been somewhat further extended. The canal now irrigates over 150,000 acres, returning about 11 per cent. on a capital outlay of 43 lakhs of rupees, and has thus become a financial success as well as fulfilling the original political expectations.

Results obtained from the construction of the Lower Swat Canal.

The introduction of irrigation by the Lower Swat Canal has changed completely the character of the tract served. Before the advent of the canal it was uninhabited and practically uninhabitable, covered with thorn bushes and not a tree to be seen. It is now, and was even in 1894, when the completion report was written, dotted throughout with villages occupied by a law-abiding and contented peasantry, and the wilderness of thorn has given place to a vast sheet of cultivation, while avenues of trees have sprung up along the roads as well as along the canal and its distributing channels The state of the tract is in every way a vast contrast to what it was when the surveys for the canal were in progress, at which time no officer was allowed to leave cantonments without himself being armed and being attended by an armed escort.

The Kabul River Canal.

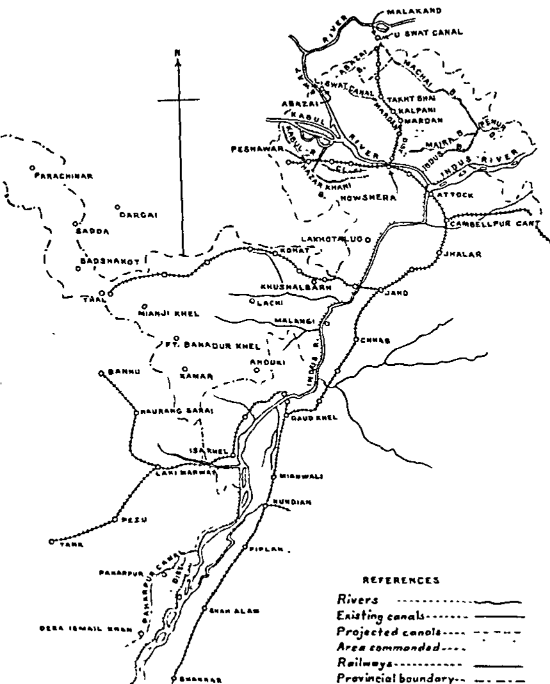
The Kabul River Canal, with its head on the right bank of the Kabul river, a short distance above Michni Fort, was constructed originally as a District Board work in 1891. In 1899, an additional branch was built to command the area between the canal and the Cherat range of hills, and in the year under review the remodelling of the canal above the off-take of this branch was carried out. The wooden aqueducts provided in the original work are being replaced by masonry structures and the question of providing further drainage crossings is also receiving attention. The canal irrigates nearly 50,000 acres, and gives a return of 5 per cent. on a capital outlay of 12 lakhs of rupees.

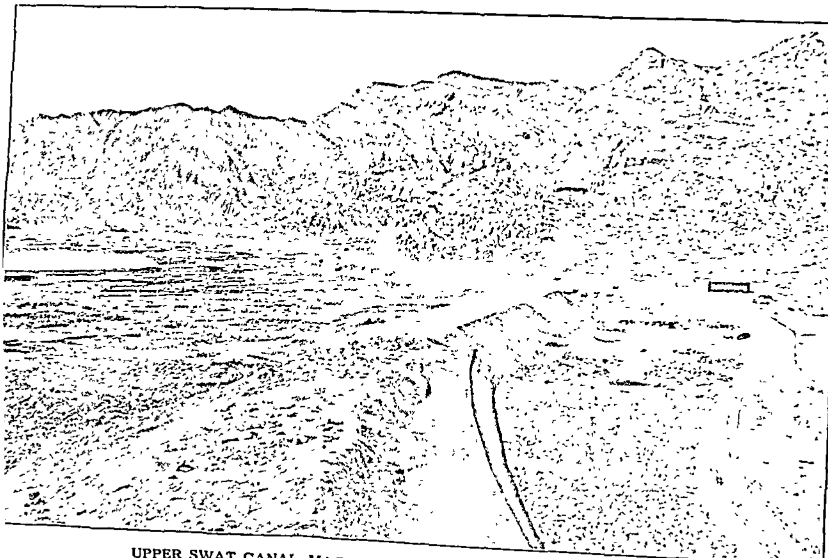
The Paharpur Canal.

The Paharpur Canal is of the inundation type and takes out of the Indus river below Bilot Fort, terminating two miles north of

N. W. F. PROVINCE
SKETCH MAP OF CANALS

Scale – 1 inch = 32 miles





UPPER SWAT CANAL, MACHAI

Dehra Ismail Khan. The canal was opened in 1907 and commands a narrow strip of land, about five miles wide, between itself and the river. The working of the system is prejudiced by two factors, the insecurity of the water-supply (the Bilot creek, from which this supply is drawn, being extremely liable to silt) and the excessive cross drainage which has not only prevented the development of irrigation but which periodically breaches the canal itself Conse-

be granted and

0,000 acres ; by

kely to be in a

revenue.

The Upper Swat Canal.

The Upper Swat Canal was declared completed at the end of the year under review. This canal derives its supply from the Swat River at Amandara between the Malakand Fort and Chakdara, and the water is conveyed by means of a tunnel, two miles long, through the Malakand Hill to the commanded area in the south. The scheme is especially interesting in its political aspect as offering the inhabitants of these frontier tracts an inducement to settle down to peaceful and prosperous methods of living The capital cost of the canal is estimated at 206 lakhs of rupees, and it is anticipated that 277,000 acres will eventually be irrigated; irrigation commenced in 1914 and is progressing satisfactorily, 7,500 acres being secured in the first year, 75,000 in the second, 96,000 in the third and 120,800 acres in the year under review. The Abazai Weir is a portion of this project, having been built below the head of the Lower Swat Canal to safeguard the cold weather supply to the district canals. Work upon it was interrupted for a time in 1915 owing to the disturbed state of the Border, but it was re-started in 1916 and is now complete except for the provision of Stoney gates, which are awaited from England. Pending their arrival suitable temporary arrangements have been made to ensure the supply.

Political effect of the Upper Swat Canal.

There can be no doubt as to the political advantages which

valueless country into a fertile agricultural land, the Moh

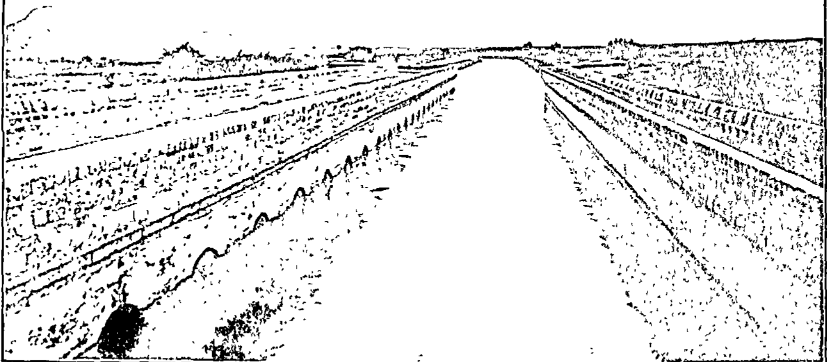
are coming in large numbers to try to secure holdings and tenancies on the canal, and the adjoining tribes come in as labourers at the time of harvest.

Progress made in irrigation since 1887-88.

The following table shows the progress made in irrigated area in the North-West Frontier Province since 1887-88 .—

	Lower Swat.	Kabul river.	Pabarpur.	Upper Swat.	Total.
1887—88	96,686	..	..	..	96,686
1897—98	138,557	..	..	..	138,557
1907—08	149,331	37,632	15,354	..	202,317
1917—18	168,448	47,677	24,966	120,811	361,902

The total area ultimately anticipated is 501,000 acres.



JINDA AQUEDUCT, LOWER SWAT CANAL.

CHAPTER XII.

BALUCHISTAN.

The Khushdil reservoir.

STATE irrigation was introduced into Baluchistan in the late eighties, when the Khushdil Khan reservoir scheme and the Shebo Canal were opened, and there are now four works in operation. The Khushdil Khan project was opened in 1889; the reservoir is formed by an earthen dam across the Timrak Nullah, about three quarters of a mile long, which was built originally with a maximum height of 60 feet. The supply obtainable from the nullah being small, the project provided for diverting water into it from the Barshore torrents by means of a boulder embankment across the latter and a feeder cut between the two streams In 1904, a second feeder was constructed from the Tor Murgha torrent into the reservoir, and in 1915 the dam was raised seven feet, thereby doubling the capacity, and a feeder channel was built so as to enable surplus water to be passed into the Shebo Canal when available in the reservoir. The maximum area irrigated from the canal is 6,600 acres, the average to date being 3,600.

The Shebo Ca[illegible]

The Shebo Canal system consists of four tanks, with a feeder channel from the Kakar Lora and a distributary system. These tanks are peculiar in that they are not natural depressions, but are formed upon the surface of the land by enclosing the area with embankments; the smallest is of 22 million cubic feet capacity, and the largest 55 million. The system irrigates a maximum area of 3,000 acres and an average of 2,000.

The Nar Null[illegible] Reservoir.

The Nar Nullah project was planned with the primary object of improving [illegible] immediate n[illegible] in a narrow [illegible] of the outlet [illegible] ation. The Nar Nullah itself has a catchment area of only six square miles, and the supply for the reservoir is principally obtained through feeders from the adjacent Spin Karez and Hanna Nulla[illegible] [illegible] never fills; the canal came into operation in 1913 and the only portion of the system for which water has so far been available is the channel which supplies the Cantonments, the maximum area irrigated being 630 acres. Designs are under preparation for the

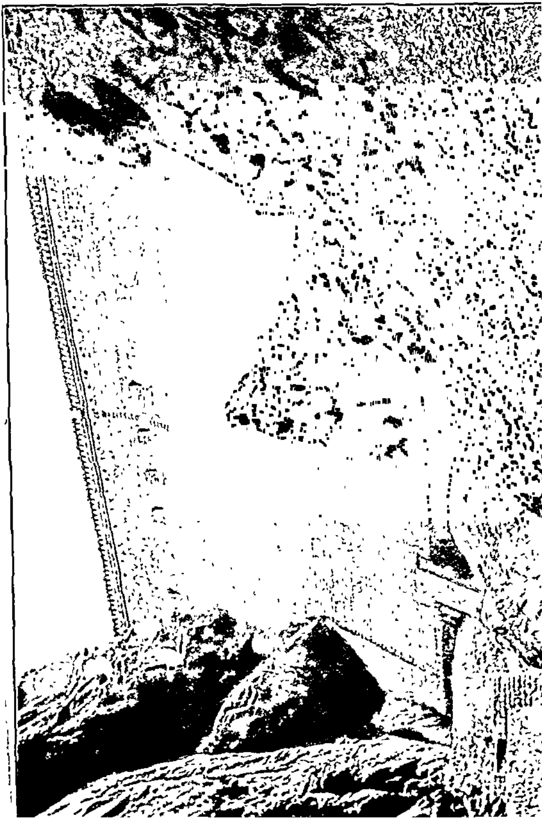
enlargement of the feeder channels so as to enable the entire floods of the nullahs to be taken into the reservoir, and the possibility of diverting water from other catchments is also under consideration.

The Nari Canal.

The Nari Canal was completed in 1888, the river supplies being diverted into the canal by means of boulder weirs erected by the local labour after every flood. In 1913 work was commenced on a permanent weir with steel shutters, at an estimated cost of nearly two lakhs of rupees, but completion has been retarded by the frequency of the floods. The Nari is the largest stream in Baluchistan and has a perennial supply of water; it is anticipated that improved results will be obtained on the canal when the new weir comes into operation.

New works proposed.

A project has been prepared for the construction of an earth embankment in the Surkhab valley, with a maximum height of 105 feet and a length of half a mile. 4,000 acres will be irrigated annually from the distributaries, which, to economize the small supply available, will be lined with concrete. Owing to the financial stringency, work on the scheme has been suspended for the present. A scheme has also been drawn up for the improvement of the Nari Canal, involving the construction of two new branches to replace the existing system of zamindari channels.



Statements showing the Financial Results of Irrigation Works for and up to the end of 1917-18.

Name of works.	General Financial results to end of 1917-18					
	Mileage in operation					
	Main canals and branches	Distributaries	Total Capital outlay (direct and indirect)	Accumulated arrears of interest	Accumulated surplus revenues.	Total sum-at-charge (column 4+column 5).
1	2	3	4	5	6	7
	Miles	Miles	Rs.	Rs	Rs.	Rs.
Brought forward .	3,849	8,268	8,72,37,856	3,07,80,011	19,83,90,414	11,80,17,867
IRRIGATION—*contd.*						
BOMBAY (SIND).						
Desert Canal	267	69	27,21,157	..	25,90,333	27,21,157
Unharwah	116	5	7,88,830	..	21,59,308	7,88,830
Begari Canal	192	52	24,39,729	..	81,18,930	24,39,729
Mahiwah	293	..	14,39,684	4,46,335	..	18,86,019
Eastern Nara Works . . .	575	..	70,40,869	..	42,81,278	70,40,869
Jamrao Canal	180	457	89,07,194	..	8,79,497	89,07,194
Dad Canal	270	91	26,68,628	5,96,847	..	32,65,475
Nasrat Canal	215	69	18,66,071	66,784	..	19,32,855
Naulakhi Canal	..	..	5,145	2,616	..	7,761
Sukkur Barrage works . .	..	..	—284	—44	..	—328
Total Sind .	2,117	743	2,78,77,023	11,12,538	1,80,29,396	2,89,89,561
Carried over .	5,966	9,011	11,51,14,879	+ 1,69, 3,18,92,549	16,858 21,64,19,810	14,70,07,428

NO. I—*contd.*

Financial results of the year 1917-18.							
Gross receipts (direct and indirect)	Working expenses (direct and indirect)	Net revenue.	Percentage on Capital outlay, column 4.	Interest at 3·4730 per cent. on direct Capital outlay to end of previous year, *plus* half the outlay of the year	Net profit	Net loss.	Area irrigated.
8	9	10	11	12	13	14	15
Rs	Rs	Rs	Per cent.	Rs	Rs.	Rs.	Acres.
1,15,22,607	28,42,954	86,79,653	..	28,39,007	66,58,006	8,17,360	2,179,873
4,52,192	1,19,872	3,32,310	12 21	91,728	2,40,582	..	103,285
2 09,867	72,624	1,37,243	17 40	26,674	1,10,569	..	83,731
6,14,409	1,54,657	4,59,752	18·84	82,203	3,77,549	..	276,250
63,201	65,097	—1,793	.	47,961	..	49,754	60,347
6 11,517	2 55,275	3,56,242	6 06	2,35,903	1,20,339	..	225,132
8,28,370	6,18,633	3,09,746	3 48	2,99,254	10,492	..	233,935
1,91,273	1,02,488	88,785	3 33	89,451	..	666	111,879
1,23,438	1,26 003	—2,567	..	62,850	..	65,417	76,333
..	..	..	..	178	..	178	..
..	..	..	..	—10	..	—10	..
					8,59,531	1,16,005	
30 94 367	14,14,649	16,79 719	6 03	9 34,192	+7	43 525	1,262,601
1,46 16,074	42 57,603	1 03,59,371	..	37,73,199	73,17,537	9,33 335	3,442,777

Name of works.	General Financial results to end of 1917-18.					
	Mileage in operation		Total Capital outlay (direct and indirect).	Accumulated arrears of interest.	Accumulated surplus revenues.	Total sum-at-charge (column 4+column 5).
	Main canals and branches	Distributaries.				
1	2	3	4	5	6	7
	Miles	Miles	Rs	Rs	Rs.	Rs
Brought forward .	5,966	9,011	11,51,14,879	3,18,92,549	21,64,19,810	14,70,07,428
BOMBAY (DECCAN AND GUJARAT)						
Hathmati Canal including Kharicut Canal.	66	67	13,15,973	9,00,701	..	22,16,674
Lower Panjhra River Works .	.	45	4,69,621	4,91,393	..	9,60,014
Kadwa River Works . . .	24	14	10,34,191	10,36,380	..	20,70,571
Pravara River Works, Lakh Canal	23	10	3,71,891	9,22,212	..	12,94,103
Mutha Canal including Matoba Tank	88	84	70,15,498	39,25,402	..	1,18,40,900
Ekruk Tank	48	2	13,40,386	15,70,142	..	29,10,528
Krishna Canal	64		9,44,459	6,01,310	..	15,45,769
Total Deccan and Gujarat .	307	212	1,33,91,019	94,47,620	..	2,28,38,649
Total Bombay .	2,424	935	4,12,68,042	1,05,60,168	- 91,47,630 1,50,29,396	5,18,28,210
BENGAL.						
				+74,69,228		
Midnapur Canal . . .	70	255	84,97,672	1,35,75,849	..	2,20,73,521
Total Bengal .	70	255	84,97,672	1,35,75,849	..	2,20,73,521
UNITED PROVINCES.						
				—1,35,75,849		
Ganges Canal	568	3,292	3,91,85,771	..	5,10,48,154	3,91,85,771
Lower Ganges Canal . . .	662	3,124	4,16,92,537	..	83,28,821	4,16,92,537
Agra Canal	100	902	1,22,76,750	..	6,67,403	1,22,76,750
Eastern Jumna Canal . .	129	796	52,30,745	..	3,93,01,627	52,30,745
Dun Canals	..	83	13,93,492	..	4,34,358	13,93,492
Bijnor Canals	..	78	3,42,964	..	5,08,491	3,42,964
Gorai Canal	..	39	8,05,689	71,709	..	8,77,398
Total United Provinces .	1,459	8,314	10,09,27,948	71,709	10,02,76,844	10,09,99,657
				+10,02,05,135		.
Carried over .	7,802	17,792	23,79,31,518	5,49,87,737	31,66,96,654	29,29,19,255

NO. I—*contd.*

Financial results of the year 1917 18							
Gross receipts (direct and indirect).	Working expenses (direct and indirect).	Net revenue.	Percentage on Capital outlay, column 4	Interest at 3 4730 per cent on direct Capital outlay to end of previous year, *plus* half the outlay of the year	Net profit.	Net loss	Area irrigated.
8	9	10	11	12	13	14	15
Rs	Rs	Rs	Per cent	Rs	Rs	Rs	Acres
1,46,16,974	42,57,603	1,03,59,371		37,75,109	75,17,537	9 33,365	3,4[illegible],777
33,194	46,019	—12,855	.	43 099	..	55,954	16,066
15,555	9,827	5,728	1 22	15,468	.	9,740	3,814
27 362	18,764	8,598	0 63	33,749	..	25,151	4,369
1,803	2,642	—839	.	12 240	..	13,079	841
4,26,354	1,87,101	2,39,163	3 02	2,64,515	..	25,352	13,953
1,06,665	17,316	89,349	6 67	42,653	46,696	..	2,384
51,071	17,618	34,453	3 65	31 013	3,440	.	3 601
6,62,904	2,99,307	3,63,597	2 72	4,42,737	50,136	1,29,276	44,864
					—79,140		
37,57,271	17,13,956	20,43,315	4 05	13,78,929	9,09,667—	2,45,281	1,307,763
					+6 64 386		
2,18,809	1 27,155	91,654	1 08	2,88,633	..	1,96,979	..
2,18,809	1,27,155	91,654	1 08	2,88,633	..	1 96 979	..
					—1,96,979		
51,13,525	13,47,933	40,65,592	10 38	12,75 367	27,90 225	..	1,215,755
36,66,210	10,37,760	26,28,453	6 30	13,48,178	12,79,075	..	970,483
8,91,686	3,23,619	5,68 067	4 63	3,97,081	1,70,986	..	252,244
16 81,258	3,70,738	13,10,520	25 05	1,69,907	11,40,613	..	323,158
1,49,671	64,618	85,053	6 10	47,053	38,009	..	21,234
70,795	31,170	39,625	11 53	10,877	28,748	..	38 025
10 813	9 831	982	0 12	26,105	..	25,153	12,158
[illegible]	31 65 635	[illegible]	8 62	32,74 868	54 49 517	25,153	[illegible]
					+54 23 364		
[illegible]	78 69 760	[illegible]	..	77 81 437	[illegible]	[illegible]	[illegible]

Name of works.	General Financial results to end of 1917 18. — Mileage in operation. Main canals and branches.	Distributaries.	Total Capital outlay (direct and indirect).	Accumulated arrears of interest.	Accumulated surplus revenue.	Total sum-at-charge (column 4 + column 5)
1	2	3	4	5	6	7
	Miles.	Miles.	Rs.	Rs.	Rs.	Rs
Brought forward ..	7,802	17,792	23,79,31,518	5,49,87,737	31,66,96,654	29,29,19,255
IRRIGATION—*contd.* PUNJAB						
Western Jumna Canal including Sirsa Branch	294	1,735	1,76,92 529	..	5,42,20,460	1,76,92,529
Upper Bari Doab Canal .	325	1,577	2,18,32,283	..	4,85,04,979	2,18,32,283
Sirhind Canal	318	1,591	2,56,31,380	..	1,92,42,141	2,56,31,380
Lower Chenab Canal . . .	427	2,229	3,25,18,571	..	13,88,42,183	3,25,18,571
Upper Sutlej Canal . . .	328	305	18,17,323	..	34,48,459	18,17,323
Sidhnai Canal	68	252	13,32,227	..	68,19,562	13,32,227
Lower Jhelum Canal . . .	195	997	1,62,25,129	..	2,00,86,879	1,62,25,129
Indus Canal	445	308	29,80,753	7,64,929	..	37,45,682
Upper Chenab Canal . . .	172	1,143	3,57,75,606	61,41,779	..	4,19,17,385
Upper Jhelum Canal . . .	128	565	4,50,37,813	1,03,26,608	..	5,53,64,421
Lower Bari Doab Canal . .	132	1,103	2,24,61,550	35,60,970	..	2,60,22,520
Total Punjab .	2,832	11,895	22,33,05,164	2,07,94,286	29,11,64,663	24,40,99,450
NORTH-WEST FRONTIER PROVINCE.				+27,	03,70,377	
Lower Swat River Canal . .	22	187	42,99,031	..	52,93,927	42,99,031
Kabul River Canal . . .	59	17	12,11,607	..	9,35,817	12,11,607
Paharpur Canal . . .	42	15	9,20,749	5,46,812	..	14,67,561
Upper Swat River Canal . .	146	312	2,08,46,174	42,80,517	..	2,51,26,691
Total North-West Frontier Province	269	531	2,72,77,561	48,27,329	62,29,744	3,21,04,890
				+14,	02,415	
Carried over .	10,903	30,218	48,85,14,243	8,06,09,352	61,40,91,061	56,91,23,695

NO. I—*contd.*

Financial results of the year 1917-18.							
Gross receipts (direct and indirect).	Working expenses (direct and indirect)	Net revenue.	Percentage on Capital outlay, column 4	Interest at 3 4730 per cent on direct Capital outlay to end of previous year, plus half the outlay of the year	Net profit.	Net loss.	Area irrigated.
8	9	10	11	12	13	14	15
Rs.	Rs	Rs	Per cent	Rs	Rs	Rs.	Acres
2,73,82,644	78,69,760	1,95,12,884	..	77,81,437	1,30,16,220	12,84,773	6,358,728
33,14,058	13,70,946	19,43,112	10 98	5,86,344	13,56,768	..	725,325
49,42,130	13,34,133	36,07,997	16·52	7,32 706	28,75,291	.	1,144,621
34,35,019	12,64,492	21,80,527	8 51	8,47,427	13,33,100	..	931,894
1,52,63,175	24,60,511	1,28,02,664	39 37	10,99,523	1,17,03,141	..	2,277,125
7,50,234	3,82,314	3,67,920	20 24	59,650	3,08,270	..	437,837
7,01,626	1,58,770	5,42,856	40 75	44,928	4,97,928	..	319,442
44,29,159	9,15 765	35,13,394	21 65	5,44,846	29,68,548	..	765,454
4,41,690	3,99,182	42 508	1 42	1,00,757	..	58,249	204,213
23,45,068	10,86 612	12,58,456	3 52	12 00,642	57,814	..	382,935
5,37,993	8,27,495	—2,89,502	..	15,13,663	..	18,03,165	177,006
16,43,347	9,13,857	7,29 490	3 24	7,53,906	..	24,416	621,600
3,78,03 499	1,11,04 077	2,66,99,422	11 93	74,84,392	2,11,00,860	18,85,930	7,956,372
					+1,92, 15,030		
6,41,096	1,78,646	4,62,450	10 78	1,44,502	3,17,948	..	163,449
1,85,320	94,845	90,475	7·46	40,262	50,213	..	47,677
55,782	81,255	—25,473	..	31,446	..	56 919	24,966
3 91 463	3 88 314	—3,851	..	6,95,479	..	6 99 310	120,811
12,63,661	7,43 000	5,23,661	1 92	9,11,669	3 68,161	7,56,229	361,903
					—3,88, 068		
6,64,52,804	1,97,16,897	4,67,35,907	..	1,61,77,498	3 44,85,241	39 26 832	14,707,003

Name of works.	General Financial results to end of 1917-18.					
	Mileage in operation					
	Main canals and branches	Distributaries.	Total Capital outlay (direct and indirect)	Accumulated arrears of interest.	Accumulated surplus revenues.	Total sum at charge (column 4 + column 5)
1	2	3	4	5	6	7
	Miles.	Miles	Rs	Rs.	Rs.	Rs
Brought forward	10,903	30,218	48,85,14,243	8,06,09,352	61,40,91,061	56,91,23,595
BURMA.						
Mandalay Canal	40	122	57,09,159	6,48,827	..	63,57,986
Shwebo Canal	76	293	59,77,628	..	19,99,574	59,77,628
Mon Canals	54	114	56,66,799	12,36,758	..	69,03,557
Yeu Canal	..	.	42,40,269	6,90,201	.	49,30,470
Total Burma	170	529	2,15,93,855	25,75,7-6	19,99,574	2,41,69,641
				—5,76,212		
BIHAR AND ORISSA.						
Orissa Project	327	1,291	2,70,68,889	4,46,76,919	..	7,17,45,808
Sone Project	367	1,235	2,68,82,472	2,04,20,921	..	4,73,03 393
Total Bihar and Orissa	694	2,526	5,39,51,361	6,50,97,840	..	11,90,49,201
				—6,50,97,840		
CENTRAL PROVINCES.						
Asola Mendha Tank	..	134	17,23,553	4,61,547	..	21,85,100
Wainganga Canal	28	122	40,30,765	4,82,428	..	45,13,193
Mahanadi Canal	105	300	74,92,494	7,44,232	..	82,36,726
Total Central Provinces	133	556	1,32,46,812	16,88,207	..	1,49,35,019
				—16,88,207		
Total Productive Irrigation Works	11,900	33,829	57,73,06,271	14,99,71,185	61,60,90,635	72,72,77,456
				+46,61,19,450		
Carried over	11,900	33,829	57,73,06,271	14,99,71,185	61,60,90 635	72,72,77,456

NO. I.—*contd.*

[illegible]							
Gross receipts (direct and indirect).	Working expenses (direct and indirect).	Net revenue	Percentage on Capital outlay (column [illegible]).	Interest at [illegible] per cent. on direct Capital outlay to end of previous year, and on half the outlay of the year.	Net profit.	Net loss.	Area irrigated.
8	9	10	11	[illegible]	[illegible]	[illegible]	[illegible]
Rs.	Rs.	Rs.	Per cent.	Rs.	Rs.	Rs.	Acres.
6,64,52 804	1,97,16,697	[illegible]	..	[illegible]	[illegible]	[illegible]	[illegible]
2,32,964	77,199	[illegible]	[illegible]	[illegible]	..	[illegible]	[illegible]
6,83,623	2,76,558	[illegible]	6·41	[illegible]	[illegible]	..	[illegible]
2,26,964	1,47,511	79 423	1 40	[illegible]	..	1,11,[illegible]	[illegible]
.	..	.	.	1,22 142	.	1,22,142	..
11,43,757	5 01,563	6,42,193	2 97	7,17,[illegible]	[illegible]	[illegible]	[illegible]
					—75 749		
5,74 391	4,86,412	87,979	0 32	9,13,013	..	8,21,034	[illegible]
19,10,400	8,31,616	10,78,784	4 01	9,01,424	1,77,250	..	[illegible]
24,81,791	13,18,028	11,66,763	2 16	18,20,437	1,77,250	8,31,034	[illegible]
					—6,53, 674		
11,810	13,695	—1,885	..	58,091	..	59,976	5,147
4 568	41,295	—39,727	..	1,28,461	..	1,68,188	1,471
57,854	47,193	10,661	0 14	2,24 235	..	2,23,571	68,176
74,232	1,05,183	—30 951	..	4,20,784	..	4,51,735	74,794
					—4 51,735		
7,01,55,584	2,16,41,676	4,85,13,908	8·40	1,91,36,656	3,48,[illegible],320	54,91,068	15,843,520
					+2,93, 77,252		
7,01,55,584	2,16,41,676	4,85,13,908	8 40	1,91,36 656	3,48,68,320	54,91,068	15,843,520

Name of works	General Financial results to end of 1917-18					
	Mileage in operation		Total Capital outlay (direct and indirect).	Accumulated arrears of interest.	Accumulated surplus revenues.	Total sum at charge (column 4+column 5).
	Main canals and branches.	Distributaries.				
1	2	3	4	5	6	7
	Miles	Miles	Rs	Rs.	Rs	Rs
Brought forward	11,900	33,829	57,73,06,271	14,99,71,185	61,60,90,635	72,72,77,456
NAVIGATION						
BENGAL.						
Tidal Canal	29	..	20,14,318	37,47,656	..	63,61,974
Total Bengal	29	..	26,14,318	37,47,656	..	63,61,974
BURMA.						
Twante Canal	22	..	58,20,715	7,18,064	..	65,38,779
Total Burma	22	..	58,20,715	7,18,064	..	65,33,779
Total Productive Navigation Works	51	..	84,35,033	44,65,720	..	1,23,00,753
				—44,65,720		
GRAND TOTAL PRODUCTIVE WORKS	11,951	33,829	58,57,41,304	15,44,36,905	61,60,90,635	74,01,78,209
				+46,16,53,730		

NO. I—*contd.*

Financial results of the year 1917-18.							
Gross receipts (direct and indirect)	Working expenses (direct and indirect).	Net revenue.	Percentage on Capital outlay, column 4.	Interest at 3·4730 per cent. on direct Capital outlay to end of previous year, *plus* half the outlay of the year.	Net profit	Net loss.	Area irrigated.
8	9	10	11	12	13	14	15
Rs.	Rs	Rs.	Per cent.	Rs.	Rs.	Rs.	Acres.
7,01,55,584	2,16,41,676	4,85,13,908	8 40	1,91,36,656	3,48,68,320	54,91,068	15,843,520
59,155	53,446	5,709	0 22	88,589	..	82,830	..
59,155	53,446	5,700	0·22	88,589	..	82,880	..
3,87,640	88,450	2,99,190	5 14	2,10,632	88,558	..	..
3,87,640	88,450	2,99,190	5·14	2,10,632	88,558	..	..
4,46,795	1,41,896	3,04,899	3·61	2 99,221	88,558	82,880	..
					+5,678		
7,06,02,379	2,17,83,572	4,88,18,807	8·33	1,94,35,877	3,49,56,878	55,73,948	15 843,520
					+2,93,82,930		

STATE

PROTECTIVE IRRI

Financial results of Protective Irrigation Work

Name of works.	General Financial results to end of 1917-18.					
	Mileage in operation		Total Capital outlay (direct and indirect)	Accumulated arrears of interest	Accumulated surplus revenue	Total sum-at-charge (column 4 + column 5)
	Main canals and branches	Distributaries				
1	2	3	4	5	6	7
IRRIGATION.	Miles	Miles	Rs	Rs	Rs.	Rs
MADRAS						
Rushikulya system . . .	80	151	50,95,333	29,64,563	..	80,59,896
Bhavanasi Project . . .		.	2,32,227	21,585	..	2,53,812
Mopad Project . . .	.		19,23,203	3,33,944	..	22,57,147
Venkatapuram Tank . . .			3,79,202	71,315	.	4,50,517
TOTAL MADRAS . . .	80	151	76,29,965	33,91,407	.	1,10,21,372
BOMBAY.						
Deccan and Gujarat.						
Pravara Canals	33	13	75,81,249	10,64,440	..	86,45,689
Chankapur Tank . .	13	10	19,17,079	7,55,263	..	26,72,342
Godavari Canals . . .	119	57	1,00,50,902	20,07,551	..	1,20,58,453
Nira Canal including Shetphal Tank	107	139	65,27,589	22,47,828	..	87,75,417
Mhaswad Tank . . .	66	43	20,96,016	23,40,838	..	44,36,854
Gokak Canal, 1st Section . .	..	..	4,12,666	5,46,070	..	9,58,736
Maladevi Tank	..	.	3,11,928	2,11,339	.. .	5,23,267
Budhibal Tank	..		5,09,578	2,17,554	..	7,27,132
Nira Right Bank Canal . .	.	.	1,27,32,056	12,58,765	..	1,39,90,821
TOTAL BOMBAY . . .	338	262	4,21,39,063	1,06,49,648	..	5,27,88,711
Carried over .	418	413	4,97,69,028	1,40,41,055	..	6,38,10,083

MENT NO. II.

GATION WORKS.

in India for, and up to the end of, 1917-18.

Financial results of the year 1917-18							
Gross receipts (direct and indirect)	Working expenses (direct and indirect)	Net revenue	Percentage on Capital outlay, column 4	Interest at 3·4730 per cent on direct Capital outlay to end of previous year, plus half the outlay of the year	Net profit	Net loss	Area irrigated
8	9	10	11	12	13	14	15
Rs.	Rs	Rs	Per cent.	Rs	Rs	Rs.	Acres.
1,93,421	59,071	1,34,350	2·64	1,62,476	..	28,126	48,776
..	..	..	..	6,969	..	6,969	..
..	..	..	..	60,469		60,469	..
..	..	..		12,379		12,379	..
1,93,421	59,071	1,34,350	1·70	2,42,293		1,07,943	48,776
					−1,07,943		
13,535	28,949	−15,414		2,41,159	..	2,56,573	3,631
7,600	24,168	−16,568	..	64,193	..	80,761	3,473
2,16,775	1,46,910	69,865	0·70	3,31,352	..	2,61,487	22,353
4,26,097	1,30,384	2,96,713	4·39	2,13,071	73,642	..	31,431
39,133	16,632	22,501	1·07	69,653	..	47,152	6,034
..	..	..	..	13,925	..	13,925	..
..	..	..	..	10,499	..	10,499	..
..	..	..	..	17,059	..	17,059	..
..	..	..	..	4,02,505	..	4,02,505	..
7,03,140	3,56,043	3,47,097	0·52	13,63,708	73,642	10,90,251	69,972
					−10,16,609		
8,96,561	4,15,114	4,81,447	..	16,05,999	73,642	11,98,194	118,748

STATEMENT

Name of works.	General Financial results to end of 1917-18.					
	Mileage in operation					
	Main canals and branches.	Distributaries.	Total Capital outlay (direct and indirect)	Accumulated arrears of interest.	Accumulated surplus revenues.	Total sum-at-charge (column 4+column 5).
1	2	3	4	5	6	7
	Miles	Miles.	Rs.	Rs.	Rs	Rs.
Brought forward .	418	413	4 97,69,028	1,40,41,055	..	6,38,10,083
IRRIGATION						
UNITED PROVINCES						
Betwa Canal . . .	167	573	83,32,486	67,22,842	..	1,50,55,128
Ken Canal	86	258	60,57,492	22,24 240	..	82,81,732
Dhassan Canal . . .	107	187	49,60,299	19,77,472	..	69,37,871
Pahuj and Garhmau Canal	20	37	8,24 733	2,62,412	..	10 87,145
Ghori Nadi Scheme . . .	.	11	4,00,460	1,41,932	..	5,42,392
Ghaggar Canal	63	53	39,56,235	3,61,194	..	43,17,429
Majhgawan Tank . . .	..	20	3,92,793	54,920	..	4,47,713
Barwar Lake and Canal . .	..		2,73,191	23,073	..	2,96,264
Bathbura Tank . .	.		58,339	5,748	..	64,087
Jaiwanti Tank . .	.	.	1,219	103	..	1,322
Belan Canal	.	.	36,155	10,661	.	46,816
TOTAL UNITED PROVINCES .	452	1,148	2,52,93,502	1,17,84 397	..	3,70,77,899
BIHAR AND ORISSA.						
Tribeni Canal	62	161	76,79,033	29,20,884	..	1,05,99,917
Dhaka Canal	19	24	5,84,379	3,42,526	..	9,26,905
TOTAL BIHAR AND ORISSA .	81	185	82,63 412	32,63,410		1,15,26 822
Carried over .	951	1,746	8,33,25,942	2,90,88,862	..	11,24,14,804

NO. II—*contd.*

Financial results of the year 1917-18.							
Gross receipts (direct and indirect).	Working expenses (direct and indirect).	Net revenue.	Percentage on Capital outlay, column 4	Interest at 3·4730 per cent. on direct Capital outlay to end of previous year, *plus* half the outlay of the year	Net profit.	Net loss.	Area irrigated.
8	9	10	11	12	13	14	15
Rs.	Rs.	Rs	Per cent	Rs.	Rs.	Rs	Acres.
8,96,561	4,15,114	4,81,447	..	16 03,999	73,642	11,98,194	118,748
2,07,213	2,19,303	— 12,000	..	2,77,603	..	2,89,693	101,950
1,04,534	1,35,453	—30,919	..	2,03,249	.	2,34 168	48,896
71,757	1,93,632	—1,21,895	..	1,64,865	..	2,86,760	30,128
13,089	7,466	5,623	0·63	27,963	..	22,340	4,071
91	34,855	—34,764	.	13,555	..	48 319	735
.	:	..	.	1,24,660	..	1,24,660	11,171
5,935	8,143	—2,208	..	13,039	..	15,247	2,887
..	..	.	.	8,387	..	8 387	..
..	..	..	..	1,970	..	1,970	..
..	..	..	..	42	..	42	..
..	..	..	..	1,157	..	1,157	..
4,02 619	5,98,902	—1,96,283	..	8,36,490	..	10,32,743	199,831
						—10,32,743	
1,15 415	2,81,216	—1,65,801	..	2,57,736	..	4,23,537	58,801
15,516	29,145	—13 629	..	19 802	..	33 431	7,170
1,30 931	3,10 361	—1,79,430	..	2 77,538	..	4,56,968	65,971
14,30,141	13,24 377	1,05,764	..	27,20,027	—4 56 968 73,642	26,87,905	384,550

STATEMENT

Name of works	General Financial results to end of 1917-18.					
	Mileage in operation		Total Capital outlay (direct and indirect)	Accumulated arrears of interest	Accumulated surplus revenues.	Total sum-at charge (column 4+column 5).
	Main canals and branches	Distributaries.				
1	2	3	4	5	6	7
	Miles	Miles	Rs	Rs.	Rs	Rs
Brought forward .	951	1,746	8,33,23,942	2,90,89,862	.	11,24,14,804
IRRIGATION—contd						
Central Provinces						
Khapri Aranda Tank .		23	3,53,934	78,147	.	4,32,091
Chandpur Tank . . .	.	72	6,69,846	1,63,202	..	8,33,048
Marowda Tank . . .	.	23	2,95,073	1,44,905	.	5,30,978
Khofa Tank . . .	..	6	96,637	45,092	..	1,41,729
Khasre Tank	.	6	1,61,386	34,239	..	1,95,625
Kusrangi Tank	..	8	1,28,084	51,413	..	1,79,497
Khairadatan Tank . .		8	91,457	39,854	..	1,31,311
Ghorajheri Tank . .	.	82	9,55,944	2,11,193	.	11,67,137
Kukerdehi Tank . .	.	6	1,03,763	41,334	..	1,45,097
Baniakheri Kurud .		10	1,85,933	76,235	..	2,62,169
Hargihan Tank . .		13	1,31,735	38,219	.	1,69,954
Pindrawan Tank . .	.	11	1,59 816	80,836	..	2,40,652
Khairbunda Tank . .	.	53	7,69,183	2,22,301	..	9,91,483
Rumal Tank . .	.	16	3,04,902	96,235	..	4,01,137
Ramtek Reservoir . .	.	206	28,72,455	7,91,780	..	36,64,235
Mara Tank	.	17	1,99,403	59,017	..	2,58,420
Barera Kalan Tank . . .	.	21	2,08,434	36,910	..	2,45,344
Tendula Canal	60	78	77,01,314	9,65,147	..	86,66,461
Carried over .	60	667	1,55,19,238	31,51,039	..	1,86,70,337
	1,011	2 413	9,88 43 240	3,22,39,921	..	13,10,95 181

NO. II—*contd.*

Financial results of the year 1917-18.							
Gross receipts (direct and indirect).	Working expenses (direct and indirect).	Net revenue.	Percentage on Capital outlay, column 4.	Interest at 3 4730 per cent. on direct Capital outlay to end of previous year, plus half the outlay of the year.	Net profit.	Net loss.	Area irrigated.
8	9	10	11	12	13	14	15
Rs.	Rs.	Rs	Per cent	Rs	Rs	Rs	Acres
14,29,141	12,24,377	1,05,764	..	27,20,027	73,612	26 87,905	384,550
13,225	5,514	8,044	2 27	11,616	.	3,572	7,127
10,695	7,183	2,909	0 43	22,355	..	19,446	6,580
4,473	3,169	1,309	0 31	13,060	..	11,751	2,252
1,609	603	1,096	1 13	3,180	..	2,084	863
1,907	867	1,040	0 61	5,466	.	4,426	652
3,686	1,473	2,213	1 72	4,126	..	1,913	1,740
1,173	797	376	0 41	3,019	.	2,643	154
6,236	7,125	—889	..	31,453	..	32,312	2,833
1,299	2,112	—813	..	3,406	.	4,219	218
3,574	13,510	—9,936	..	6,146	..	16,082	1,410
4,863	4,127	736	0·65	4,430	..	3,694	2,139
4,989	2,739	2,250	1 18	6,027	..	3,777	2,081
10,616	8,597	2,019	0 26	25,382	..	23,363	7,366
2,083	5,533	—3,450	..	10,305	..	13,755	750
17,398	15,742	1,656	0 05	95,144	..	93,488	10,013
3,219	2,344	875	0 43	6,686	..	5,811	1,247
3,789	2,067	1,722	0 82	7,008	..	5,286	[illegible]
..	4,415	—4,415	..	2,44,079	..	2,48,494	[illegible]
94 662	87,920	6,742	..	5,02 858	..	4,96,146	[illegible]
15,24 803	14 12 297	1 12,506	..	32 22 915	73 612	31 84 051	[illegible]

Name of works	General Financial results to end of 1917 18.					
	Mileage in operation		Total Capital outlay (direct and indirect).	Accumulated arrears of interest.	Accumulated surplus revenues.	Total sum-at-charge (column 4 + column 5)
	Main canals and branches.	Distributaries.				
1	2	3	4	5	6	7
	Miles	Miles	Rs.	Rs.	Rs.	Rs
Brought forward	1,011	2,413	9,88,45,240	3,22,39,921	..	13,10,85,161
	60	667	1,55,19,298	31,51,059	..	1,86,70,357
IRRIGATION.						
Central Provinces—concld.						
Naleshwar Tank	.	22	5,76,433	69,759	.	6,46,192
Jamunia Tank	..	37	4,97,407	71,394	..	5,68,801
Kattanjheri Tank	..	21	1,89,543	24,770	..	2,14,313
Chorkhamara Tank	..	..	5,82,149	49,042	..	6,31,191
Bodulkassa Tank	..	15	4,72,071	37,113	..	5,09,184
Pariat Tank	..	..	87,071	1,845	..	88,916
Total Central Provinces	60	762	1,79,23,972	34,04,982	..	2,13,28,954
Grand Total Protective Works	1,011	2,503	10,12,40,914	3,24,93,844	..	13,37,43,758
				—3,24,93,844		

NO. II—*concld.*

Financial results of the year 1917-18							
Gross receipts (direct and indirect).	Working expenses (direct and indirect)	Net revenue	Percentage on Capital outlay, column 4	Interest at 3 4730 per cent on direct Capital outlay to end of previous year, *plus* half the outlay of the year	Net profit.	Net loss.	Area irrigated.
8	9	10	11	12	13	14	15
Rs.	Rs	Rs	Per cent	Rs.	Rs.	Rs	Acres.
15,21,803	14,12,207	1,12,505	..	32,22,915	73,612	31,81,051	435,535
94,662	87,920	6,742		5,02,883	..	4,96,146	50,995
1,112	9,783	—8,671	..	18,778	..	27,449	321
1,989	3,632	—1,643	..	16,507	..	18,150	1,053
1,733	2,500	—767	..	6,257	..	[illegible]	727
..	..	..	..	17,385	..	17,385	..
2,169	1,840	329	0 06	14,570	..	14,241	1,233
..	..	..	..	1,647	..	1,647	..
1,01,665	1,05,675	—4,010	..	5,78,032	..	5,82,042	54,324
					—5,82,042		
15,31,806	14,30,052	1,01,754	0 10	32,98,059	73,642	32,69,917	435,574
					—31,96,205		

STATEMENT

MINOR WORKS AND NAVIGATION FOR WHICH

Financial results of Minor Works and Naviga

Name of works.	General Financial results to end of 1917 18.					
	Mileage in operation		Total Capital outlay (direct and indirect)	Accumulated arrears of interest	Accumulated surplus revenues	Total sum at-charge (column 4+ column 5)
	Main canals and branches.	Distributaries				
1	2	3	4	5	6	7
	Miles	Miles	Rs	Rs.	Rs.	Rs.
IRRIGATION						
Madras	668	594	1,09,22,034		..	1,09,22,034
Bombay—Sind	1,905		49,08,324	41,035	3,30,89,353	49,49,359
Bombay—Deccan and Gujarat	268	276	90,71,172	1,00,12,116	43,958	1,90,83,288
United Provinces		580	40,54,708	..	..	40,54,708
Punjab	110	106	5,92,071	11,00,411	11,98,235	16,92,482
Burma	..		46,20,164	.	..	46,20,164
Bihar and Orissa	11	12	7,14,806		..	7,14,806
Central Provinces		110	22,38,817		..	22,38,817
Rajputana			34,62,154		.	34,62,154
Baluchistan	17	91	41,97,230	19,04,176		61,01,406
Total Irrigation	2,979	1,729	4,47,81,480	1,30,57,738	3,43,31,544	5,78,39,218
				+2,12,73,806		
NAVIGATION						
Madras	304	.	93,31,722	..	.	93,31,722
Bengal	.	..	1,37,43,104	.	.	1,37,43,104
Total Navigation	304	..	2,30,74,826			2,30,74,826
Grand Total, Minor Works and Navigation.	3,283	1,729	6,78,56,306	1,30,57,738	3,43,31,544	8,09,14,044
				+2,12,73,806		

NO. III.

BOTH CAPITAL AND REVENUE ACCOUNTS ARE KEPT.

tion in India for, and up to the end of, 1917-18.

Financial results of the year 1917-18.							
Gross receipts (direct and indirect).	Working expenses (direct and indirect)	Net revenue.	Percentage on Capital outlay, column 4.	Interest at 3 4730 per cent. on direct Capital outlay to end of previous year, *plus* half the outlay of the year.	Net profit.	Net loss.	Area Irrigated.
8	9	10	11	12	13	14	15
Rs.	Rs.	Rs.	Per cent.	Rs.	Rs.	Rs.	Acres.
8,01,375	2,42,380	6,58,095	5 12	3,49,358	2,09,637	..	152,807
19,38,580	5,33,080	14,05,500	28 63	1,62,498	12,43,002	..	892,107
1,70,803	1,21,963	54,840	0 62	2,92,094	..	2,37,254	36,238
3,32,475	1,37,474	1,95,001	4 81	1,30,260	64,741	..	139,507
1,58,133	95,212	62,921	10·83	19,840	43,081	..	64,435
13,73,707	1,83,827	11,89,880	25 75	..	11,89,880	..	419,141
1,000	505	495	..	..	495	..	Canals closed,
6,913	15,321	— 8,408	..	..	..	8,408	; 4,114
1,17,616	73,717	43,899	1 27	1,15,255	..	71,356	..
61 398	28,296	26,102	0 62	1,26,297	..	1,00,195	16,849
49,61,000	14,31,775	35,29,225	7·68	11,05,602	27,50,836	4,17,213	1,725,196
					+23,33,623		
79,538	1,51,081	—71,543	0·77	3 06,503	..	3,78,046	..
7,18 907	5,49,688	1,69,219	1·20	..	1,69,219	..	..
7,98,445	7,00,769	97,676	0·42	3,06,503	1,69,219	3,78,046	..
57,59,445	21,32,544	36,25,901	5 34	15,02,105	29,20,055	7,95,259	1,723,196
					+21,24,796		

STATEMENT NO. IV.

Showing the progress made in the development of major works (productive and protective) during the last 30 years.

Year.	Mileage of channels		Capital outlay of year.*	Capital outlay to end of year †	Net revenue.	Area irrigated.
	Main Canal	Distributaries.				
	Miles.	Miles.	Lakhs of rupees	Lakhs of rupees	Lakhs of rupees	Thousands of acres.
1888-89 . . .	6,542	19,096	51	2,629	101	6,555
1889-90 . . .	6,650	20,303	36	2,675	109	7,041
1890-91 . . .	6,165	21,399	58	2,733	124	7,177
1891-92 . .	6,232	22,315	81	2,941	127	7,560
1892-93 .	6,620	22,541	60	3,002	139	7,036
1893-94 .	6,687	23,277	76	3,030	125	6,953
1894-95 . . .	6,740	23,800	65	3,148	129	6,193
1895-96 . . .	6,753	24,313	74	3,226	126	7,955
1896-97 . . .	6,839	25,475	79	3,300	201	10,173
1897-98 . . .	6,857	26,018	74	3,387	238	10,246
1898-99 . . .	7,186	26,971	68	3,457	222	9,853
1899-1900 . .	7,168	27,431	94	3,554	231	10,918
1900-01 . . .	7,383	28,337	93	3,652	250	10,922
1901-02 . . .	7,836	28,463	89	3,744	244	11,649
1902-03 . . .	8,012	25,740	91	3,849	274	11,832
1903-04 . .	9,187	26,738	90	3,951	284	13,008
1904-05 . . .	9,229	27,231	76	4,031	293	12,641
1905-06 . . .	9,440	27,659	120	4,163	282	14,676
1906-07 . .	9,456	27,350	166	4,336	351	13,631
1907-08 . . .	10,430	28,755	183	4,583	327	14,286
1908-09 . . .	10,635	29,690	203	4,795	335	14,469
1909-10 . . .	*10,843*	*30,511*	*219*	*5,030*	339	14,252
1910-11 . . .	11,029	30,877	232	5,271	344	14,163
1911-12 . . .	11,398	30,664	286	5,563	378	15,258
1912-13 . . .	11,763	32,257	273	5,810	436	14,649
1913-14 . . .	12,272	33,165	278	*6,089*	*475*	15,243
1914-15 . . .	12,366	34,155	252	6,333	460	16,051
1915-16 . . .	12,574	34,800	108	6,535	459	15,614
1916-17 . . .	12,782	35,635	124	6,666	503	17,439
1917-18 . . .	*12,911*	36,337	105	6,788	486	17,418

* Direct expenditure only.
† Direct and indirect expenditure.

G. M. Press, Simla.—No. 9 P.W.D.—4-6-19—1,300—K.C.M.